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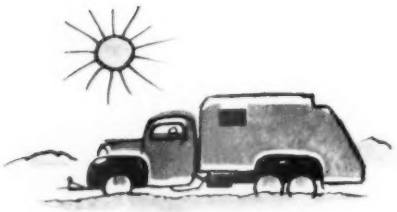
Petroleum Technology

JUNE, 1952



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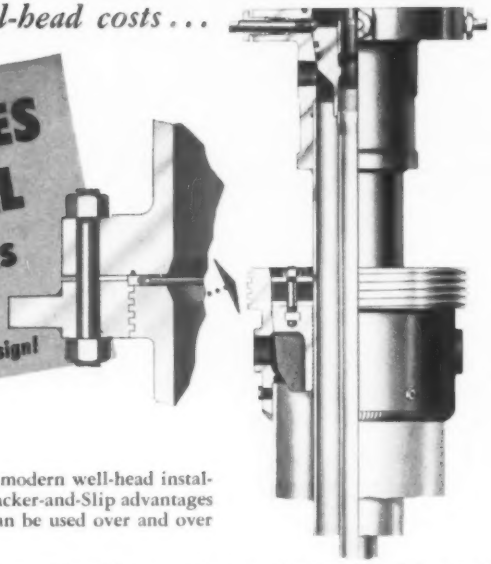

Here's another important Baash-Ross saving in modern well-head installations . . . equipment that combines the latest Unitized-Packer-and-Slip advantages with the added economy of Demountable Flanges that can be used over and over again, thus saving substantially on well head costs.

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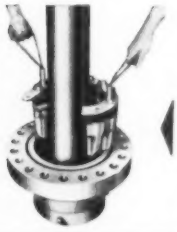
Because the multiple-drilled flanges and bolts represent a substantial portion of the cost of a complete well head assembly, important savings are made by salvaging these parts—and the saving continues to increase with each additional well on which they are used!

But demountable flanges are only part of the savings . . .



In addition to being able to salvage the flanges, "UPS-DF" Heads also have another important advantage . . . a **Unitized Packing-and-Slip** design in which both the slip segments and the packing element are unitized into a single compact assembly that simply *w-r-a-p-s* around the casing, then is locked in place by inserting *one* bolt.

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2. **Unitized Packer and Slips** eliminate threads, grooves or other packer retaining devices, permitting maximum compactness.
3. **Elimination of Threads** and grooves provides a smooth bowl with nothing to become damaged during drilling operations—no need for protective sleeves or other complications.
4. **Unitized Slip Segments** are locked together for a perfect "set" every time. No risk of crimping the casing or of an unequal grip that may fail in service.
5. **Slips are Set** and packing tightened without stripping and without first cutting the casing.
6. **The Unique B-R Weld-Test Feature,** so popular with leading operators, permits pressure tightness of both casing welds to be tested simultaneously with a gauge and hand pump as part of the installation procedure (or any time later). Imperfect welds can be corrected before welder leaves the rig—any subsequent leaks can be quickly repaired by injecting plastic pack material. Provides leak protection throughout life of the well.

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Journal of Petroleum Technology

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TABLE OF CONTENTS

Editorial Features — Section 1

Editorial: Why Members Should Vote to Continue the Present Scale of Dues, by Michael L. Haider . . . 9
The Effect of Calcium Chloride on High Early Strength Cement, by B. C. Craft and A. H. Stephenson . . . 11
The Engineer and the Industry Information Program, by Robert E. Featherston 14
Technical Note: Measurement of the Permeability of Set Cement, by B. E. Morgan and G. K. Dumbauld . . 16
Water Flooding in Eastern Kansas and Oklahoma, reported by D. M. Moon 17
Education for Petroleum Production, reported by R. H. Burke 18
Shale Oil Research in Laramie, Wyoming, reported by R. D. Ferguson 19
Geophysical Exploration Methods, reported by J. A. Klotz 20
The Redwater Field, Alberta, Canada, reported by W. B. Davis 21
"The Influence of Permeability on Ore Distribution in Limestone and Dolomite," a review by Silvain J. Pirson 22

Petroleum Transactions

Visual Examinations of Fluid Behavior in Porous Media — Part I, by Alfred Chatenever and John C. Calhoun, Jr. 149
Drilling Fluid Filter Loss at High Temperatures and Pressures, by F. W. Schremp and V. L. Johnson . . 157
Experimental Evaluation of Well Perforation Methods as Applied to Hard Limestone, by Henry Lewelling . . 163

Institute Affairs — Section 2

Drift of Things, by Edward H. Robie 3
Nominees for Petroleum Branch Offices, 1953 4
Petroleum Branch Membership 5
Personals 6
Employment Notices 8
Book Reviews 10
Advertisers' Index 10

On the Cover — It's a long way down, from this derrickman's view of the Humble Rig 20 at Lake Washington Field, Louisiana. The photo may well be symbolic of the "long way down" to production for drillers and engineers on similar rigs all over the world. Developments in drilling and well completion are given special emphasis in this issue. *Photo courtesy Humble Oil and Refining Co.*

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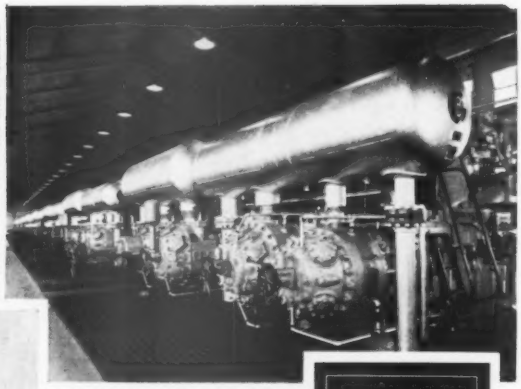

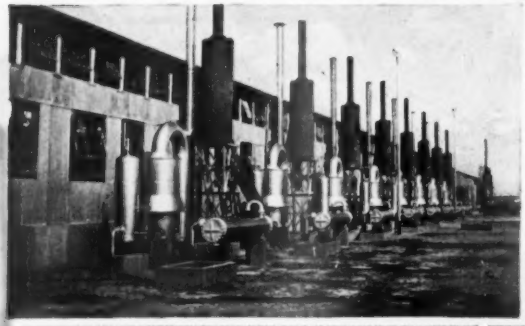

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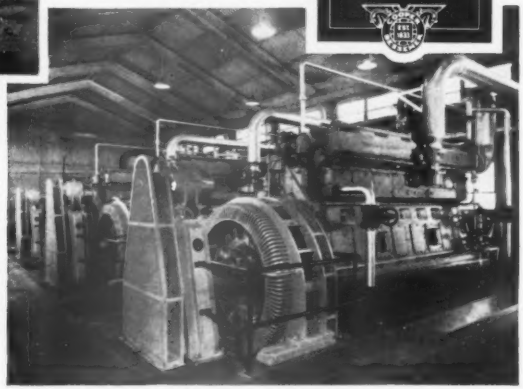

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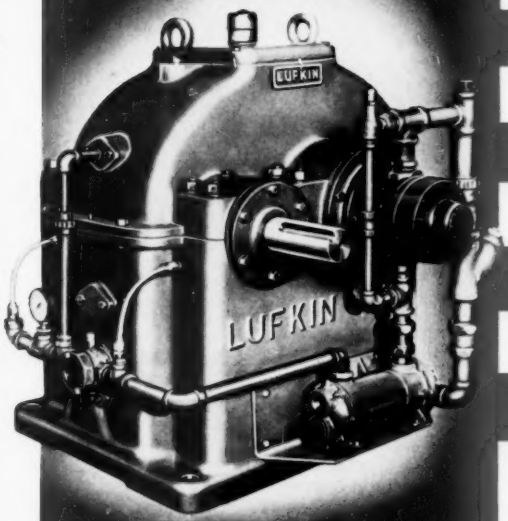

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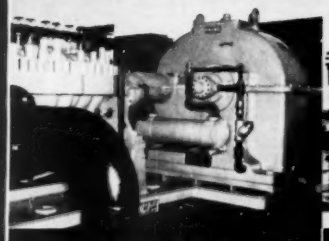

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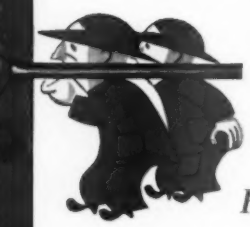

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Editorial

Why Members Should Vote To Continue the Present Scale of Dues

By Michael L. Haider
Standard Oil Co. of New Jersey
President, AIME

THREE years ago AIME members were asked to vote on an increase of $5 in the annual dues for Members and Associate Members and of $2 for Junior Members. This increase in Institute income was made necessary by a long series of deficits, that for the year 1948 alone being $82,000. The increase was voted by 78.5 per cent of the voting members of each of the Mining and Metals Branches and by 77.4 per cent of the members of the Petroleum Branch. The proposal, later expressed in the by-laws, was that the increase should obtain for three years only, 1950, 1951 and 1952. It was felt that the situation should again be surveyed in 1952. You will therefore now again be called on to vote as to whether or not the present scale of dues shall be continued, as is recommended by the Board of Directors. You will receive a ballot during June if you are a paid-up member living in the United States, Canada or Mexico.

The increase in dues reduced the deficit in 1950 to $15,000, and last year a surplus of $8,000 was achieved in spite of continuously rising costs. A surplus of about the same amount is indicated for 1952.

The Institute income is largely derived from two sources: (1) dues and initiation fees, and (2) advertising and sale of publications. Last year 59 per cent of the income was from the first source and 39 per cent from the second, leaving 2 per cent from miscellaneous sources. In 1949 a new publication policy was adopted whereby we put out three magazines, each in specialized fields, instead of *Mining and Metallurgy* as previously. The objective of this policy was not only better to serve the members, but also to attempt to increase our advertising income. In 1949, advertising income was $86,000 compared with $103,000 in 1950, $144,000 in 1951, and $165,000 (estimated) in 1952.

Your board has given serious consideration to reductions which might be made in Institute expenses. As a result of these studies, the Institute headquarters staff has been reorganized and equipment is being modernized, which will bring increased efficiency and maximum operating economy. A growing membership and continued inflation caused Institute expenses to increase seven per cent in 1950 over 1949, and one per cent in 1951 over 1950, and a small increase is expected for 1952. The number of regular paid staff employees of the Institute was exactly the same at the end of 1951 as it was at the end of 1949.

A detailed analysis of AIME income and expense, both as to totals and on a per-member basis, covering the year 1951, appeared in the April issue of the JOURNAL OF PETROLEUM TECHNOLOGY. Most national engineering societies, and others in the mineral technology field, have been forced to increase their dues to offset inflation in printing and material costs as well as salaries. Your board feels that the Institute can stay on a sound financial basis by maintaining the present scale of dues.

If AIME dues should revert to their former level, it is estimated that income from this source would drop by approximately $69,000. This loss of income would have to be met by a reduction in expense, as the Institute can no longer sustain deficits from its special funds. To reduce expenses by this amount, it would be necessary to reduce the staff and severely cut the Institute's publications. Decreased service to members would result, and your Board feels that services are already at a practical minimum, and are being rendered in accordance with the wishes of the majority of the membership.

The price level — the value of the dollar — is so uncertain in its present trend that the income and expenses of the Institute are difficult to project into the future. If it should appear safe to do so, your Board of Directors has the power to reduce dues in the years ahead. On the other hand, dues can only be increased by vote of the membership.

You are strongly urged to return the ballot to be sent you in June so that the returns will be as representative as possible of the wishes of the membership. You are also urged to give your Board of Directors a vote of confidence by authorizing them to continue the present scale of dues (Members and Associate Members, $20; Junior Members, $12 for the first six years of membership, thereafter, $17). ★ ★ ★

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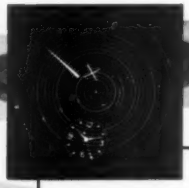

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The Effect of Calcium Chloride On High Early Strength Cement

By B. C. Craft, Member AIME, and A. H. Stephenson
Louisiana State University, Baton Rouge, La.

Tests reported here indicate how considerable time can be saved on shallow cement jobs. Calcium chloride can also be used to accelerate setting on certain plug-back operations, and to reduce shrinkage when sealing split casing.

TESTS were performed to determine the pumping time, initial setting time, final setting time, and compressive strength of high early strength cement when calcium chloride was added as an accelerator. The tests showed conclusively that all the properties mentioned above were greatly altered.

While the pumping time was substantially shortened by adding calcium chloride, the remaining pumping time was adequate to permit the placing of a cement slurry in a well at the depths where high early strength cement is ordinarily used. The short period of time required for the slurry to reach the final set indicates that the waiting-on-cement time may be substantially reduced.

These conclusions are drawn from the cementing time required as set up by API Code 32, Schedule 2, and by determining the minimum waiting-on-cement time when calculated by the Farris[1] equation.

These tests indicate that considerable time may be saved on shallow cement jobs. The acceleration of the setting time of high early strength cement makes this cement more convenient to use on certain plug-back jobs. In addition, the low shrinkage factor of high early strength cement when calcium chloride has been added makes such a mixture very desirable to use when the problem is to seal a split in the casing.

Introduction

The competitive nature of the petroleum industry makes it desirable for the operators to conserve as much time as possible in completing various stages of the drilling program.

One of the great losses of time in the Gulf Coast area is the waiting-on-cement time. Since Farris[1] has established a minimum waiting-on-cement time to eliminate unnecessary waiting periods, the next logical step is to increase the speed of setting of the cement. Calcium chloride has been added to standard portland cement as an accelerator and the results are available.[2] To follow this start, calcium chloride was added to high early strength cement in an attempt to find the best mixing ratios and obtain data that are applicable to field engineering work.

Paper presented before the Delta Section, AIME, May, 1951.

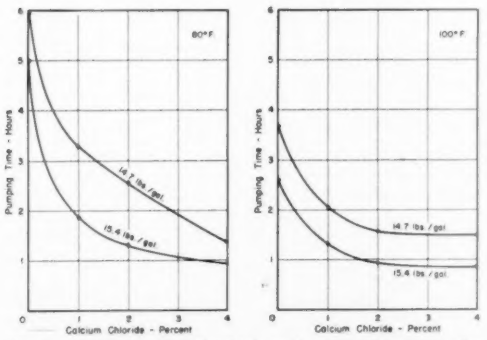

Fig. 1 — Pumping time for high early strength cement plus calcium chloride.

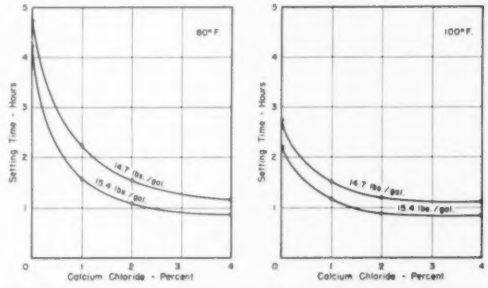

Fig. 2 — Initial setting time for high early strength cement plus calcium chloride.

Method of Testing

The tests were performed on slurrys weighing 14.7 lb per gal and 15.4 lb per gal and maintained at 80°F and 100°F, in order to simulate as nearly as possible field conditions encountered on conductor and surface pipe jobs. The procedure outlined in API Code 32 was followed, using a Halliburton Thickening Time Tester to determine the pumping time and the Gillmore Method to determine the setting time. The calcium chloride was added to the mixing water, a technique which may be followed in the field by putting the calcium chloride into the measuring tanks on the cementing truck. In addition, the mixing technique was checked by determining the weight of each mixture with a Baroid Mud Weight Balance.

The results of the tests on pumping time, initial and final setting times, and the compressive strength of the different samples are presented in Figs. 1-5.

Discussion of Results

As can be seen in Fig. 1, the amount of acceleration desired can be obtained by varying the amount of calcium chloride, and Fig. 4 shows that the strength of high early strength cement is not seriously affected by the addition of a small amount of calcium chloride.

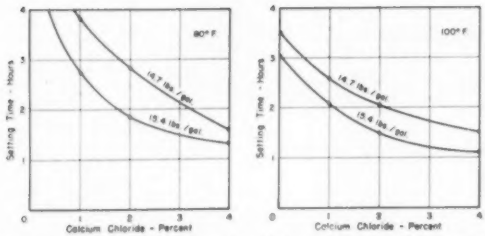

Fig. 3 — Final setting time for high early strength cement plus calcium chloride.

Figs. 2 and 3 show the effect of calcium chloride on the time for initial and final set and, when compared with Fig. 1, the relation to pumping time.

Farris[1] showed that the minimum waiting-on-cement time was equal to the pumping time to 100 poises multiplied by 3. In Fig. 1 it is shown that the pumping time for a slurry weighing 15.4 lb per gal and containing 2 per cent calcium chloride, when tested at 100°F, had a pumping time of 56 minutes.

From the data presented in Fig. 5, the compressive strength at minimum waiting-on-cement time of 168 minutes would be 125 psi. A conservative compressive strength of 500 psi is reached in 6.5 hours, which would require a multiplier of 7 times the time to 100 poises.

It was observed that the ratio of set volume to slurry volume is greater when calcium chloride is used.

The variable not considered in these tests was pressure. However, it has been shown by Craft, Johnson and Kirkpatrick[3] that the properties of a cement slurry are affected only a negligible amount at pressures less than 1,500 psi.

Applicability of High Early Strength Cement Plus Calcium Chloride

API Code 32, Schedule 2, establishes a total cementing time of 27 minutes for a 300 sack job at 2,000 ft. This figure allows 18 minutes for mixing and 9 minutes for pumping. Using these figures as a basis for the usual South Louisiana job of 750 sacks, it is evident that the mixing time will be 45 minutes.

The pumping time will still be 9 minutes, which gives a total cementing time of 54 minutes. From the pumping time curve for a 14.7 lb per gal slurry with 2 per cent calcium chloride, maintained at 100°F, a pumping time of approximately 100 minutes is available. This gives a pumping safety factor of nearly 2.

Based on the Farris[1] equation the minimum waiting-on-cement time is found to be approximately 300 minutes or 5 hours, obtained by multiplying the pumping time by 3.

In addition to the advantages on routine casing jobs it may be desirable to use high early strength cement plus calcium chloride to combat certain lost-circulation problems. Commercial products have been used very successfully to solve these problems in the past but they are not applicable under some conditions. When these conditions are encountered, a high early strength cement mixed with calcium chloride can be set and drilled after waiting only a little longer than would be necessary when the commercial products are used.

Since the shrinkage is reduced by adding calcium chloride, this property may be utilized when the problem is to seal a split in a joint of casing.

Summary

It has been shown that a considerable amount of waiting-on-cement time at shallow depths may be saved by adding small amounts of calcium chloride to high early strength cement. Certain other problems such as lost circulation and split casing may also be solved more satisfactorily by using this mixture.

Acknowledgment

The authors wish to express their appreciation to the Trinity Portland Cement Division of General Portland Cement Co. for donating the high early strength cement.

References

1. Farris, R. Floyd: "Method for Determining Minimum Waiting-on-Cement Time." *Trans.* AIME, (1946) **165**, 175.
2. Halliburton Oil Well Cementing Co., Duncan, Okla.
3. Craft, B. C.; Johnson, T. J.; Kirkpatrick, H. L.: "Effect of Temperature, Pressure and Water-Cement Ratio on the Setting Time and Strength of Cement." *Trans.* AIME, (1935) 114, 62.

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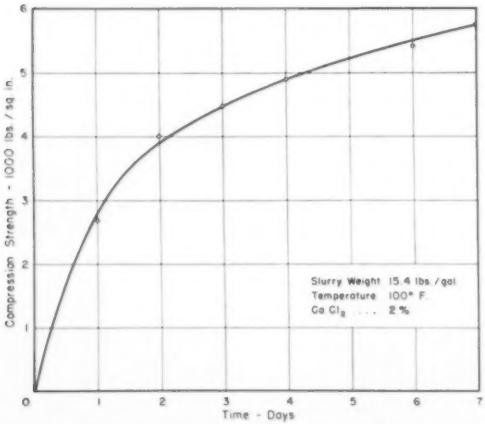

Fig. 4 — Compression strength for high early strength cement plus calcium chloride.

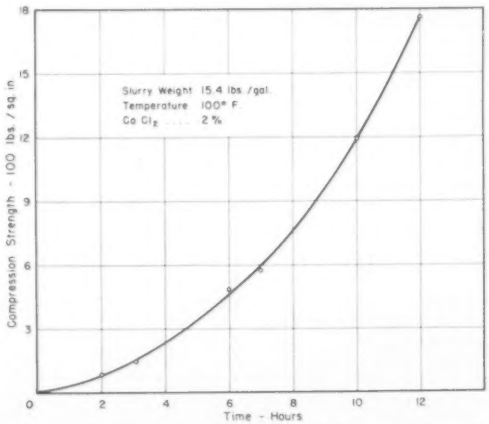

Fig. 5 — Compression strength for high early strength cement plus calcium chloride.

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Erle P. Halliburton

Chairman of the Company
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Duncan, Oklahoma

The Engineer and the Industry Information Program

By Robert E. Featherston
Oil Industry Information Committee
American Petroleum Institute

The American public, in general, holds some highly unsympathetic views of the oil industry. The solution, this author believes, lies in an industry-wide public relations plan, in which the engineer, as well as management, has a definite role.

MEN of vision in the oil world are concerned, but not worried, about the challenge the future holds. Regardless of the outcome of the present series of Korean truce meetings, the months and years ahead will be full of problems. War is a constant possibility on any of a number of fronts. On the other hand, if we are permitted to cooperate with Uncle Sam to the full extent of our ability, our industry can shift — on short notice — to an all-out war effort. If the government allows our industry to function with all the efficiency of which private enterprise is capable, no fighting man will want for oil and its by-products. No United States or Allied soldier, sailor, marine or airman has ever wanted for these things — thanks to the efforts of the American oil man.

This industry of ours supplied four-fifths of the oil needed to win against the Central Powers in World War I.

During World War II, when task forces of oil men of all descriptions went everywhere with the troops and the Air Force, each and every invasion depended on oil. Ships that pounded the beachheads, planes that softened enemy outposts, landing craft, transports and freighters all consumed enormous quantities of petroleum products. Armed forces of the United Nations (excluding Russia) used 22 billion gal of petroleum to conquer Germany — not counting products used to transport men and materials to the scene of action.

A B-29 could easily consume 10,000 gal of high-octane gasoline during one long flight. An armored battalion required 17,000 gal to move just 100 miles, and the United States Fifth Fleet burned 630 million gal in seven weeks. No wonder that, over the entire period of the war, petroleum constituted from 55 to 65 per cent of all tonnage carried to the various theaters.

Today, the oil industry is, as always, cooperating wholeheartedly with agencies of the government, in the tremendous task of meeting military needs, and keeping civilian economy on an even keel. Thousands of companies, individuals and trade associations — are involved.

Much work remains to be done, despite the fact that an API survey indicates that no matter what may happen, our armed forces are assured of adequate supplies of the liquid fuels, lubricants, explosives, and other oil products they may need.

An official of the Department of the Interior reports that, although no one knows what the future may bring, Washington has not had, and does not now have, plans for total mobilization of the oil industry. We are also told that only a shortage of steel could cause the rationing of oil, because supplies are abundant.

Of these things, oil men are all aware. But what of the American public? Is it aware of our unceasing efforts, both in time of peace and of war, to keep this great nation free and unshackled — to give them a superior standard of living unknown elsewhere in the world? What *does* the public think of us?

As I answer those questions, I am sure you will begin to realize why we need an Oil Industry Information Committee in every town in the country.

Address before the AIME Annual Meeting in New York, N. Y., Feb. 18-21, 1952.

In 1946, the Public Relations Committee of the API, and other industry leaders, apprehensive of the dark clouds of public opinion, financed a survey revealing that: 57 per cent of the adults in America thought this industry guilty of collusion to fix prices of petroleum products; that 33 per cent considered it a monopoly; that 25 per cent believed we held back new scientific developments; that 20 per cent thought we were wasteful of natural resources; and that 20 per cent were positive that we made excessive profits. Therefore, is it not understandable that 16 per cent of adult America favored government ownership or control of the oil industry?

One ray of hope appeared, however, during that survey. Further questioning had revealed that those persons having no conception of how this industry was operated were the ones believing it guilty of the aforesaid charges, while those who were somewhat familiar with its operations held it in high regard. Obviously, the job was, and is, to see that everyone is given the facts that will enable him to see this industry in the proper light. An educational and informational program, being the only answer, was decided upon at once.

The nation was divided into districts, each comprising several states, and the work began. Area, or county, officers were selected, and efforts were made, and are still being made, to set up a community committee in every town boasting a newspaper or a radio station.

The activities of a community O.I.I.C. fall into three major categories, each handled by a special committee.

1. *The Work of the Speakers and Movies Committee:* Primarily securing spots for oil movies and speeches on programs at meetings of school, civic, farm, business and professional groups — and seeing that they are properly filled.

2. *The Work of the Press-Radio-Television Relations Committee:* Making and maintaining friendly working contacts with local newspaper and radio and television station personnel, compiling and supplying them with oil data and information for stories, arranging for them to use O.I.I.C. materials — such as interviews and movies — on their programs, etc.

3. *The Work of the Industry Participation Committee:* Organizing, and carrying to completion, special projects such as poster and essay contests in schools, parades, exhibits at fairs, displays in prominent locations, oil men-community leader meetings and open houses.

Those are the year-'round activities of the community O.I.I.C., which are being supplemented by our special quarterly emphasis program. Perhaps I should explain that program. While it is the consensus that we should press forward toward our long range objectives, by redoubling our efforts to continue and improve our regular program, it is thought that much might be gained by again, as in 1951, placing special emphasis on reaching different important groups during each of the four quarters of the year.

We, therefore, concentrated our efforts on farm audiences during the first quarter of 1952, and on women's audiences during the second. During July, August and September we

shall personally present a supply-demand report to every newspaper, radio and TV editor in the nation. Preparations for Oil Progress Week (Oct. 12-18) will also be made during this period. The final quarter will be devoted to OPW, OPW reports and reaching community leaders in each and every town boasting a local O.I.I.C.

The work laid out for all of the functional committees of a community O.I.I.C. can be handled equally as well by producer, pipeliner, geophysicist, marketer, royalty owner, doctor of petroleum research, refiner, or petroleum engineer. We have found that many oil men have felt this to be a program for marketers and public relations men, alone. Obviously, nothing could be farther from the truth.

The last two surveys reveal that the oil industry has gained in public favor since 1946. Some of the changes are small — others are considerably bigger — but practically all are in a favorable direction.

This, of course, is excellent, but, before we become even a mite optimistic, consider the findings of another survey — conducted by Junior Achievement, a national youth organization. This survey revealed that most of our young people believe companies earn about 24 per cent profits, that stockholders earn 15 per cent annually on their investments, and that the average company investment per worker is $81. The survey also revealed that thousands of our modern 'teen-agers favor government control of *all* American business!

After hearing the findings of this survey, you may wish to do something to better inform the youth of your community — to see that it knows what America stands for — that it understands, respects and advocates the incomparable free enterprise system.

Now, as to things outside of the realm of ordinary O.I.I.C. activities, in which you — a petroleum engineer — may be helpful: Despite the fact that all O.I.I.C. materials are so prepared and slanted as to be suitable for use by members of all segments of the industry, the fact remains that there are some things of a public relations nature that can best be handled by specific groups of oil men. Several of our public relations problems might rightfully be considered the responsibility of the petroleum engineer, and you, in your routine work as a company public relations man may already be working on them.

You, of course, are aware that you have been handling public relations for your company ever since the day you were first employed. You may have handled them in grand style — or in a most miserable manner, but everything you have done, everything you have failed to do, every purchase you have made, every "yes" or "no" that has passed your lips has been a public relations move — *for*, or *against*, your company. In times gone by, your and your company's public relations may not have been of prime importance to you, but they had better be important to you today. In those days, men and companies asked but *two* questions before closing a deal: 1. Is it profitable? 2. Is it legal? If the answers were "yes" to both, they closed the deal. Some were not too concerned with getting a "yes" to question 2. Now, a third question must be considered, "Will the public approve?" Today, no company can long exist if it disregards public opinion. The people can legislate any company, or any industry, right out of business. So, we must, at all times, be courteous, considerate, polite, diplomatic, and — *above all* — ethical, to a fault. These things you know. Now, back to our public relations problems that might rightfully be considered the responsibility of the petroleum engineer: Our initial public opinion survey, conducted in 1946, revealed that, despite the great strides our industry had taken in the field of conservation, 20 per cent of America's adults charged it with being wasteful of the natural resources. No one is better fitted to lead our fight to refute this unfounded charge — to correct this misunderstanding in the minds of millions — than the reservoir engineer. Therefore, we feel we have the right to ask him to take advantage of every available opportunity to explain, and sell the idea of, conservation, not only to regulatory bodies before which he normally appears, but to all other groups before which his appearance can be arranged.

Too, since his testimony is valuable to regulatory bodies, and often influences their decisions in matters involving sizable sums of money he, like important athletes and politicians of this day and age, is sometimes subjected to attempts at bribery. We can but admonish him to abide by the time honored code of ethics of the engineering profession. By so doing, he can win the respect of everyone, for himself, his company and the entire petroleum industry.

Though the production engineer's responsibility lies chiefly in getting the oil out of the ground, treating it, etc., often, upon going into new territory, he becomes the contact man between his company and the property owners, as well as the communities nearby. In this capacity, he plays the role of a public relations man, and as such should be ever mindful that the impressions he makes may have a lasting effect, either good or ill, on the public relations status of the entire oil industry.

About two years ago, a booklet entitled "The Ranger's Side" was given wide distribution in West Texas. It set forth the numerous surface damages inflicted upon the landowner by the oil companies while exploring for and developing oil properties. It ably presented their side of the story and encouraged a workable solution.

In fairness, the production engineer should, whenever possible, work to bring about a more compatible relationship between land owner and oil company — that is, to develop better public relations. And, since sound public relations calls for well-rounded consideration of entire communities, he might well call on the editor of the local paper, the county commissioner and officials of the Chamber of Commerce — explaining the company's problems and answering any questions they might care to ask.

It would also be well if he could talk informally with members of the crew, giving them a few simple pointers on the careful treatment of property, and emphasizing the fact that they cannot afford to be careless in their relations with the property owners and townspeople.

If it could be arranged, he might address the local civic and professional groups, clarifying his company's operations. Such talks could easily become the greatest single forward step in securing its acceptance in the communities.

Now, getting back to petroleum engineers in general—those in direct charge of employees should always remember that public relations begins at home, and make every effort, within reason, to foster a friendly relationship between those employees and the company. It has too often been proved that, in one angry blast of criticism, an employee soured on his company can lose for it much of the good will created over a long period of time.

No list of public relations pointers to petroleum engineers, especially those in executive capacity, would be complete unless it included a reminder of the importance of keeping current on the problems of their industry, and having at hand the latest information on all phases of its activity. The public expects you to be informed on such matters, and to be in position to answer its questions regarding them. A great deal of this information will be furnished you in routine mailings, should you decide to become affiliated with the O.I.I.C. movement in your community. ★ ★ ★

Technical Note 120—

MEASUREMENT OF THE PERMEABILITY OF SET CEMENT

B. E. MORGAN, JUNIOR MEMBER AIME AND **G. K. DUMBAULD,** MEMBER AIME, HUMBLE OIL AND REFINING CO., HOUSTON, TEX.

INTRODUCTION

A satisfactory well-cementing composition must retain its fluidity long enough to be pumped into place; then it must develop within a reasonable length of time sufficient strength and impermeability to anchor the casing in position and to form an effective seal between the casing and the formations. These properties may be evaluated by pumpability, strength (compressive or tensile), and permeability tests. Laboratory test procedures for the determination of pumpability time and strength development have been outlined previously and are readily available,[1] but a satisfactory and convenient laboratory procedure for the measurement of the permeability of set cement has not been developed heretofore.

Some permeability data have been obtained previously by passing air through dried cement specimens.[2] Such a procedure is unsatisfactory because the drying of set cement alters its physical and chemical properties and subjects it to conditions dissimilar to well conditions. A more realistic method would be one wherein the cement remains water-saturated during the aging period and the permeability is measured with water. Such a procedure, outlined below, has been used by the authors for the past four years to evaluate well-cementing compositions.

PERMEABILITY TEST PROCEDURE

The brass mold, shown in the upper left-hand corner of Fig. 1, is cleansed with emery polishing paper and placed on a flat plate and the test slurry is poured into the mold. The slurry is puddled several times with a stirring rod and levelled off with a spatula. Another flat plate is placed on top of the mold to complete the enclosure before the mold is placed under water at the desired curing temperature. After the cement slurry has aged for the desired length of time, the mold containing the set cement is taken from the water bath, the cover plates are removed, and the specimen is cooled under water to room temperature. The faces of the set cement (in the mold) are brushed under a stream of water to remove the glazed surface and foreign matter. The mold is then sealed, with its larger face downward, into the specially designed cylinder by means of O-rings as shown in Fig. 1. To prevent the collection of any air in the water and under the specimen, the following procedure is followed:

1. With mercury in the system as shown, valve *A* closed, valves *B*, *C*, and *D* opened, connect an aspirator bottle containing distilled water, recently boiled, to valve *C* by means of a rubber tubing and fill chamber until water overflows through valve *D*.

2. With valves *B*, *C*, and *D* closed and valve *A* opened, adjust air regulator to obtain the desired pressure drop across the cement specimen by observing the pressure gauge *G* (25-100 psi, generally).

3. Conect aspirator bottle to valve *E*.

4. With aspirator bottle positioned 12-24 in. higher than valve *E*, open valves *D* and *E* slightly to allow a small flow of water past the mold containing the set cement as the cap is screwed into place.

5. Close valve *E* and open valve *D* fully.

6. Attach measuring tube (a one-ml pipette with tip removed) as shown in Fig. 1.

7. Connect aspirator bottle to valve *F* and bring water level into measuring tube, then close valve *F*.

8. Observe rate of flow and calculate permeability using Darcy's Law.

9. To replace water in the system, close valve *A*, open valve *B*, connect aspirator bottle to valve *C*, then open valve *C*.

DISCUSSION

In making exploratory tests, several variations in test procedure were tried. In some cases, the mold was greased with a light, water-insoluble grease prior to placement of the

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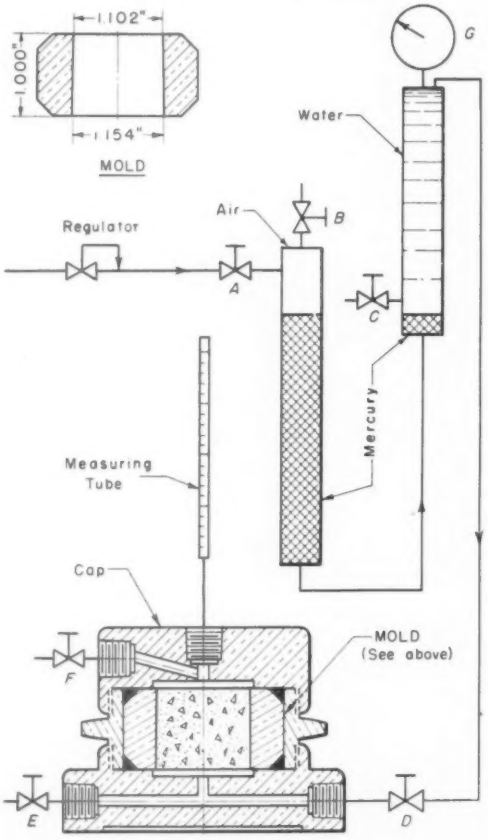


FIG. 1 — CEMENT PERMEAMETER.

[1]References given at end of paper.

Manuscript received in the Petroleum Branch office April 23, 1952.

Water Flooding in Eastern Kansas and Oklahoma

Reported by D. M. Moon
Illinois Basin Chapter

John R. Lavens, Jr., Oil Field Research Laboratories, spoke on "Water Flooding Practices in Eastern Kansas and Oklahoma" at a meeting of the Illinois Basin Chapter last month. Water flooding operations in this area have been widespread since the late 30's, Lavens said, and future attempts are expected to profit from the mistakes made during this early period. A summary of his remarks follows:

Up to the present time most of the water flooding in the Oklahoma-Kansas area has been confined to six well known sands: Peru, Squirrel, Burbank, Bartlesville, Cromwell and Tucker. There is one water flood in limestone. The formations occur as shoe strings and off-shore deposits. Most water floods in that area can be classed as secondary recovery projects, although there is one water pressure maintenance development project of the Squirrel sand in Kansas and one which was begun on Cromwell sand in Oklahoma last summer. Water flood depths in the area range from 225 to 3,500 ft. The gravity of the oil ranges from 18 to 40° and viscosities run as high as 125 cp.

Almost every type of equipment has been used; partly because some of the projects are very old and partly because the depths vary widely. Electricity, purchased or generated, is the principal source of power. Well spacing ranges from 220 ft to 1,320 ft. The five-spot is the most popular pattern on sheet sands. Rectangular, diamond, line and staggered line patterns have been adopted on shoe strings. Coring has been utilized quite extensively in recent years in helping to decide on spacing and pattern policies. Some operators plug out all old wells and redrill entirely. Others keep some old wells and a few drill only enough new wells to balance out the patterns.

Both brine and fresh water are used for flooding. The principal source of salt water is the Mississippi lime and the Wilcox sand. Various methods of conditioning are followed. On most projects the water is brought into open pits or tanks and treated. There are some closed systems where there is no treatment.

Cement lined pipe is being used in most input systems and operators are tending more toward the use of bronze meters. The use of central meter houses is becoming widespread. Lead lines are usually cement lined pipe or plastic.

Shallow Water Floods

Where the formation is less than 1,000 ft deep, it has been the custom to use two- to three-acre spacing, partly because of the lower cost per well and partly because it seems that shallower formations, due to weak contacts and a tendency to fracture, seem to break down under high pressure, thus requiring lower input rates. However, since operators have become interested in more detailed preliminary reservoir study, they are finding they can spread to five or six-acre spacing in some cases. In most instances all old wells have been plugged out and the leases completely redrilled, though for the past three years it has been recommended to keep old producers wherever practical. Generally speaking, in the shallow areas, water input rates have been held to less than four bbl/ft, though higher rates have been successfully applied on some leases around Nowata. Rates as low as two bbl may be recommended where the formation viscosity of the oil exceeds 35 cp.

Some floods are pumped and some are flowed from the beginning. Most shallow floods are flowed during the later stages. A few operators follow delayed drilling. Most input wells are equipped with tubing cemented on rag packers. When the lease is to be flowed from the beginning the producers are equipped like the input wells. Most wells are shot.

Medium Depth Water Floods

At depths of 1,000 to 2,000 ft, 10-acre spacing has almost become the rule. Above 1,300 ft most operators have drilled all new wells, but below that it has been the practice to drill new input wells and keep the old producers. However, during the last year the use of old wells for intakes has been preferred where practical. Input rates are necessarily higher, in the order of 10 to 15 bbl/ft. Many injection wells have not been shot. Some operators have used two-in. tubing in intakes but 5½-in. pipe is becoming standard. Parts of some floods have been flowed during the later stages.

Deep Water Floods

At depths of 2,000 to 3,500 ft, most old wells are utilized although a few operators still prefer 10-acre spacing and must drill new input wells. However, below 2,500 ft, with the exception of one operator, every one has cut new drilling to the minimum and most spacing is 20 acres. In a few cases the input rates are as high as 40 bbl/ft. A very detailed study of the reservoir and a careful pilot are desirable before using such an input rate. On the few floods that are deeper than 3,000 ft 40-acre spacing is being used. They have not progressed far enough to give conclusive results.

Water Flooding Problems

Like any water flooding area the Oklahoma-Kansas area has plenty of maintenance and producing problems. In shallower floods break-downs, due to fractures, are encountered. At any depth permeability break-downs frequently are encountered in the later stages. Problems due to thief sands, which grade into pay, often occur. Fractures and permeability break-downs can sometimes be remedied by selective plugging.

During the past two years operators have been more careful in watching input wells and have been running breakthrough curves to try to catch these troubles in their early stages. The problem of thief sands has been serious. In most cases where this problem has been encountered the reservoir is not closed. In a few cases delayed drilling has helped remedy this situation. There has been some trouble on completions where the casing seat is soft or cavey. Operators have sometimes tried to get around this problem by using jet shots or eliminating shooting entirely.

The Kansas-Oklahoma area has had its share of corrosion problems. The most serious ones occur down hole in the producers, especially where a water flood is initiated after an air repressuring project. Both Contol and formaldehyde have been used quite extensively. The Oklahoma-Kansas area is large, so the types of water floods and the circumstances and conditions must necessarily vary. ★ ★ ★

Education for Petroleum Production

Reported by R. H. Burke
Pacific Junior Group

A panel of four speakers appeared before the Pacific Junior Group last month in Downey, Calif., to develop various aspects of the topic, "Education for Petroleum Production." Panel members were Wayne Glenn, regional engineer for Continental Oil Co. and Chairman of the Pacific Petroleum Chapter, AIME; S. T. Yuster, professor of petroleum engineering at UCLA; Jerol Sonosky, exploitation engineer for Shell Oil Co.; and Dale Johnson, student at USC.

Glenn, representing the viewpoint of management, directed his remarks primarily to the students.

The engineer working toward advancement and a managerial position must possess an analytical attitude, Glenn stated. Therefore, management is most interested in selecting graduates who will be able to analyze problems assigned and carry through with minimum supervision.

Factors to be considered in selecting the student most capable for such work include:

1. The educational institution, degree, and course.
2. The background in pure science. Grades are important, but this does not mean straight A's. Points of interest include strong and weak subjects, likes and dislikes, why a course was failed, and whether a student was strong in analytical or memory courses.
3. Outside activities, including offices held in social organizations, which help to judge leadership, personal salesmanship, diversified interest and fellowship.
4. Knowledge of industry trends, prospects, market conditions in general and current events in industry.
5. Neatness in preparation of forms and in appearance.
6. Fundamental correctness of speech.
7. Ease with which applicant talks, self-assuredness.
8. Evidence of a creative mind, as indicated by hobbies and interest.
9. Family background, and if married, background of wife.

It is sometimes necessary to hire recent engineering graduates for research or technical positions. However, most positions in an oil company require training in the applications of engineering principles. For this reason the majority of companies put each graduate through a formal trainee course for a period of from 18 to 24 months.

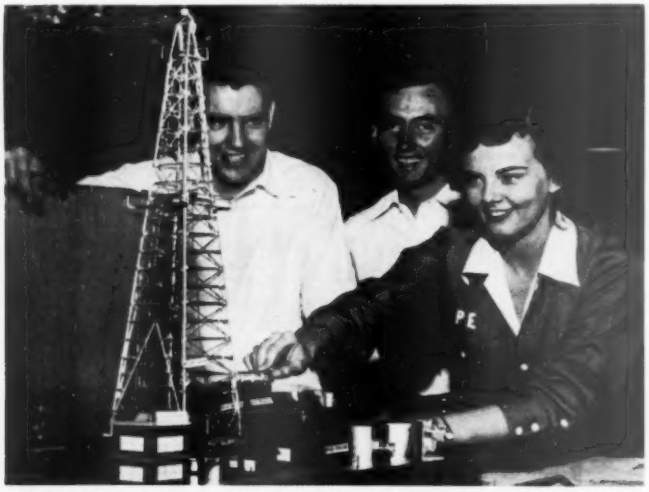
According to Glenn, the most outstanding deficiency of recent graduates is their lack of ability or training to *apply* technical skill. They are unable to analyze problems and outline an approach to solution. Few graduates realize this shortcoming. In general the graduates will follow a book of instructions or a formula to crank out an answer. They must be taught to go one step further and analyze results to determine if the answer is reasonable.

Glenn feels there is insufficient training to stimulate creative thinking and initiative. The small number of patents by production engineers is evidence of this weakness. An indication of lack of initiative is the request often made by the trainee that he be furnished an outline of what management wants him to learn or observe during each phase of his trainee course. Often the engineer can follow a job specification, but has no idea how to work on jobs not specifically covered. He misinterprets the purpose of a job specification.

"Engineers, with a few notable exceptions, are introverts of the worst order," Glenn stated. Few people have more of a selling job than an engineer, since he frequently makes recommendations that involve large expenditures. The engineer must sell the project on sound recommendations, presented in a brief report written in terms the boss understands. The engineer may be called upon personally to discuss phases of the problem. Because of his inability to talk the manager's language, his good idea often dies.

Yuster, representing the educator's viewpoint, stated that the petroleum engineer must acquire a background of fundamentals in college. These fundamentals should include mathematics at least through calculus, physics, chemistry, geology, general engineering, humanities, and petroleum engineering. These academic subjects develop a factual background. But a factual background is not enough.

The engineer must be able to correlate facts, and must be able to apply facts. Hand in hand with this ability for correlation and application goes the understanding of processes. The engineer must know the why of facts. He must also be able to communicate eas-



SCALE MODELS OF OIL FIELD EQUIPMENT are designed by petroleum engineering students at the University of Oklahoma for the annual Openhouse and Exposition, which draws several thousand visitors each spring. Here, Anne Warren, junior and the only girl in the PE school, puts the finishing touches on an offshore drilling rig, while W. R. Price and Bill R. Hise look on.

ily either by written report or in talking to others.

Graduate work, or a fifth year, can do a great deal to improve the engineer's analytical ability. It will also broaden his knowledge of fundamentals. One of the more important aspects of graduate work, however, is the development in the engineer of the research approach, an approach which is valuable in operational fields as well as in direct research activity.

Industry can be helpful in two ways. It can provide more and better qualified people from industry for extension study and staff teaching. It can also provide opportunities for experience to the students through summer employment, off-time employment and the trainee programs. A three semester program would be helpful in this respect. Yuster suggests a program whereby the schools would provide students yearround to the industry to fill certain positions, each of three students working for one semester each. Before this program could be effective, students would have to be convinced that college is a full-year job.

Extra-curricular activity is also of importance. The student organizations and professional societies can do much to develop the engineer's personality. An ideal curriculum as set forth by Yuster would consist of the following: math, 17 units; physics, 10 units; chemistry, 19 units; geology, 9 units; geophysics and geochemistry, 6 units; general engineering, 60 units; humanities, 10 units; petroleum, 12 units; total, 143 units.

Jerol Sonosky, a recent engineering graduate, commented on the duties of a junior engineer as related to his education as a petroleum engineer.

Sonosky feels that emphasis must be placed on courses in basic engineering principles and on advanced geology courses. The basic engineering courses should be given in such a way as to make their application to geology, production, etc., apparent. Advanced geology courses are well suited to give the student the necessary training in analytical problems. The company training programs help the student correlate what he has learned in school with the practical application of this knowledge. The experience gained in the training programs is sufficient and is not the problem of the schools, he believes.

As to improvements that might be made in the educational program of production engineers, Sonosky thinks the fundamental general courses should be stressed more emphatically. Structural geology and sedimentation courses should be more complete. A general knowledge of mineralogy is sufficient, but the student must learn how these rocks are affected in the field.

Additional courses in writing and English are needed. The typical engineering graduate does not fill management's demands for report writing. Courses in report writing and English should keep the needs of management in mind at all times.

Dale Johnson, representing the student, stated that a major problem in the education of a petroleum engineer is reaching a happy medium between practical or applied courses and courses containing the basic fundamentals.

From the student viewpoint, according to Johnson, the desire to study practical courses seems to rank above the desire to study theory and calculations

Continued on Page 7, Section 2

Shale Oil Research in Laramie, Wyoming

Reported by R. D. Ferguson
Wyoming Petroleum Chapter

A two-day joint meeting of the Wyoming Petroleum Chapter with the Wyoming Section was held at Laramie, Wyo. Tours were conducted of the shale oil plant laboratories, the University museum, the Natural Resources Research Institute where coal hydrogenation experiments are being carried out, and the Union Pacific ice plant near Laramie.

Ralph Espach, U. S. Bureau of Mines, gave a preliminary lecture on the laboratories of the oil shale plant. The lab is one of the most modern in the country, Espach said, and specializes in physical chemistry for rapid identification of compounds extracted from shale oil. The mass spectrometer, infra-red and ultra-violet spectrograph, and chemical methods are utilized. Experiments are being run from low temperature-pressure extraction to relatively high temperature-pressure extraction, with a corresponding change in products recovery. The high nitrogen and sulphur impurities associated with retorting shale are removed and converted to useful chemicals. Various catalysts are tried. The Badger columns are extra long, permitting a fine separation of hydrocarbons. The lab experiments are converted to improvements in retorting in the field.

In the oil lab, experiments are run on cores for gas drive and water flooding. Equipment used for bottom hole sampling includes a new variable volume cell for handling condensate.

H. M. Thorne, in charge of oil shale research, gave a synopsis of oil shale experimental work.

He stated that oil shale is not a competitor of petroleum under present conditions, but is a large source of petroleum production. All petroleum products can be made from shale oil except lubricating oils. The shale area covers about 1,000 square miles, is 500 ft thick and averages 15 gal/ton. The Mahogany ledge now mined averages 30 gal/ton, and is 70 ft in thickness. The Bureau has run 17,000 assays on shale samples from local and foreign sources. The richest is 100 gal/ton from Australia, and comes from a thin bed. The Bureau has made a study of all the constituents of kerogen including side products, such as phenols, tar acids and tar bases. The waxes from shale oil represent unsaturated hydrocarbons. All types of retorting, including the Union Oil Co. continuous retort, have been used experimentally. High temperature retorting produces the aromatic series. The gasoline produced is off-color and contains gums which have to be treated out. Low pressure hydrogenation reduces the nitrogen and sulphur in the end products.

The mining appears to be a slicing system of room and pillar, with rooms 60 ft in width. The ceiling has a four to one safety factor. The mine can load out 1,700 to 2,000 tons daily. One shift is used for drilling, one for shooting, and one for loading, resulting in 100 tons per man shift at a cost of 48 cents per ton.

J. D. Love of the USGS spoke on the recent discovery of uranium ores in Johnson and Campbell counties, Wyoming. The various methods of detecting the ore in the field were explained, black light, geiger counter and oscillograph. Most of Wyoming uranium ores are secondary in deposition and show by black light, except the manganese ores of Campbell-Johnson counties, which analyze 15 per cent uranium oxide and are commercial in character, if sufficient ore body can be located. The instruments used for mapping from photographs were explained, and the methods used to improve the accuracy of producing maps. ★ ★ ★

Geophysical Exploration Methods

Reported by J. A. Klotz
Pacific Technology Forum

R. A. Peterson of the United Geophysical Co. gave the first of a series of talks to be presented by the Pacific Technology Forum on "Elements of Petroleum Production." The series will present the highlights of petroleum engineering fundamentals for the benefit of operating engineers who may have grown rusty on a few of the "whys" of their profession and for the benefit of recently graduated engineers who may find the series useful in bridging the gap between academic and industrial problems.

Peterson presented a review of three geophysical methods for determining subsurface contours. These methods, seismic, gravimetric, and magnetic, all depend on contrasts in properties between subsurface rocks.

Seismic Methods

The seismic method is popular because it yields more data than the other methods; whereas gravimetric and magnetic methods show only average properties of all subsurface rocks, the seismic method shows properties of rocks at particular depths. Thus, this method permits vertical as well as horizontal segregation of rock structure.

Two types of seismic measurement, each depending on a different principle, have been used. The refraction method depends on differences in the velocity of sound through different rock strata; the reflection method depends on the reflection of sound waves as they pass from one rock stratum to another. A sound wave is reflected, at least partly, by any sudden change in the elastic properties of the medium the wave is traveling through. Echoes from a cliff are the result of sound reflection at the boundary between air, a light nonrigid medium, and rock, a dense rigid medium. Echo fathometers, which detect the boundary between water and ocean bottom, and reflection seismic instruments, which detect the boundary between rock strata, both rely on this principle.

In seismic exploration, the sound impulse is generated by the explosion of a dynamite charge. In order to avoid excessive absorption of the sound energy by loose weathered surface rocks, the dynamite charge, which may be as small as a few ounces or as large as 100 pounds, is fired below the water table at the bottom of a shot hole. From the shot hole, the sound wave spreads spherically, at each interface between rocks of different elastic properties part of the wave is reflected according to the laws of geometrical optics. Sound waves travel in straight lines through rock strata and at reflection surfaces angles of incidence and reflection are equal. The fraction of the sound that is reflected depends on the elastic property contrast between adjacent rock layers; usually 5 to 10 per cent of the incident energy is reflected at each interface.

Geophones, which are sensitive to sonic vibrations in rocks as microphones are sensitive to sound in air, detect the reflected sound energy by converting the vibration of the earth into recorded oscillograph traces. Earliest geophones used mechanical links to transmit the vibration to mirrors. Light rays, reflected from the oscillating mirrors, trace the vibration on photosensitive paper. Modern geophones, which use electrical links, are more convenient, however, because their output may be electronically filtered and amplified to yield maximum usable data.

In order to distinguish between random noise and strong reflections from major subsurface structure changes, several geophones, usually 12 to 24, record each shot. The records from all geophones are traced to one sheet. Whereas random noise deflects each geophone trace differently, a strong reflection deflects each trace the same way. In usual practice, geophones are strung along a one- or two-thousand ft cable. Reflections reach each geophone at a slightly different time, and traces of the reflections appear, on the graph of geophone output as a function of time, as a series of similar peaks running diagonally across the graph strip. Arrival times of the reflections are determined by "picking" the places on the record strip where the peaks line up.

Electronic control of the geophone output consists of filtering and of controlling the volume automatically. Most reflection sound is between 20 and 120 cycles a second, and amplifiers for use in seismic exploration are built with maximum gain in this frequency range. Random noise of frequency below 20 or above 120 cps is not amplified enough to show on the oscillograph record. Because of absorption and divergence of sound energy as it travels from the shot to the reflection surface and back to the geophone, shallow reflections are stronger and excite geophones more than deep reflections. To maintain more or less uniform trace deflections, each seismic amplifier contains an automatic gain control that increases gain by as much as 1,000-fold by the time reflections from 10,000 ft reach the geophone.

Whereas the reflection method is used more often now than the refraction method, earliest seismic exploration (detection of salt domes in 1924) was performed with the refraction method. This method makes use of sound waves that (1) travel downward from the shot to a high velocity layer, (2) are refracted parallel to the bedding in the high velocity layer and (3) are refracted upward to the surface as they re-emerge from the top of the high velocity layer. Data are more difficult to interpret from the refraction method than from the reflection method, because the refraction method uses a sound wave which travels in three distinct paths, whereas reflection waves travel in only two paths, incident and reflected; and because the refraction angle depends on the relative velocity of sound in the two rocks at the interface whereas reflection angles are geometrically determined. In West Texas, Edwards Plateau, however, a high velocity layer near the surface makes the refraction method more useful than the reflection method.

The precision with which depths can be measured is limited by the "bluntness" of the probing seismic wave and by the variation in sound velocity through rocks. To estimate this velocity and to determine the variation of velocity with depth in any region, the travel time of sound is measured between a dynamite shot and a geophone that is hung at a known depth in a well. As many well surveys as possible are made and sound velocity for each depth is interpolated or extrapolated from the surveyed wells to the exploration area. With good velocity data, depths may be estimated to within 25 ft and reflection surfaces 100 ft or more

apart may be distinguished, but lack of velocity data, or undetected changes in velocity, destroy precision. In West Texas, velocity changes between survey wells may cause depth measurement errors of 2,000 ft. In areas covered by glacial drift, velocities near the surface change rapidly and depth estimates are poor. Because many strong reflections are composite in nature and are the result of reflections that have been added together from three or four surfaces, strata less than 100 ft apart often cannot be resolved.

Gravimetric Method

The gravimetric method depends on variation in the average density of subsurface rocks. Igneous basement rocks are more dense than overlying sediments; thus, high gravity meter readings may indicate a protrusion of the basement rocks upward into the sediments. These protrusions often form oil traps. For example, the gravity field on the flanks of a salt dome is less intense than the field away from the dome. A high density cap on the dome, however, may cause a gravity high immediately over the dome.

Because the gravimetric method cannot precisely resolve vertical variation, its greatest use is as a reconnaissance tool. Gravity instruments are more portable than seismic equipment and gravity readings can be made much more rapidly than seismic shots. Modern gravity instruments are spring balances capable of detecting a change in the gravity field of one part in one hundred million.

Magnetic Methods

Magnetic prospecting originated as a method for detecting iron ore beds. The method makes use of magnetic fields that are stronger at the earth's surface where sediments are thin and basement rocks are near the surface than where sediments are thick. Thus, the magnetic method, as the gravimetric method, yields data that show the average properties of subsurface rocks without precise vertical differentiation. The magnetic method is limited, however, more than the gravimetric method by changes in the properties of basement rocks. Magnetic changes within the basement rocks may be as great as 1,000-fold and may mask completely magnetic effects associated with small elevation changes. The method is useful, however, as a reconnaissance tool. The air-borne magnetometer, developed by Gulf, is perhaps the most widely publicized method for petroleum prospecting. It allows survey of large areas in a very short time. ★ ★ ★

The Redwater Field, Alberta, Canada

Reported by W. B. Davis
Mid-Continent Section

At the regular monthly meeting of the Mid-Continent Section, a joint meeting with the Reservoir Study Group, a panel of three speakers discussed the Redwater Field in Alberta, Canada. W. A. Bruce of the Carter Oil Co.'s Research Laboratory in Tulsa presided. R. V. Knowles, district engineer for the Imperial Oil Co. in Calgary, discussed "Reservoir Data and Field Performance." A. G. Weber, research engineer with the Carter Oil Co. in Tulsa, spoke on the "Electrical Analyzer Studies" of this field. The third speaker was H. J. Welge, also a research engineer with Carter, who reviewed studies being made on Redwater cores.

The Redwater Field, discovered in 1948 by Imperial Oil Co., contains about 38,000 acres and over 900 producing wells. The field produces from a Devonian reef, usually referred to as the D-3 member of the Woodbend formation. The reef itself is about 900 ft thick and covers about 200,000 acres. The oil saturated closure amounts to about 200 ft.

Average porosity is between six and seven per cent. Because of the vugular fractured nature of the reservoir rock, the permeability is extremely high. The original bottom hole pressure was 1,050 psig and the saturation pressure about 500 psig. The oil produced has a gravity of about 35° API. Original stock tank oil in place is estimated at about 1,400,000,000 bbl.

As of the first of 1952 the field has produced about 40,000,000 bbl of oil. This oil production has been accompanied by a small volume of water production. Material balance calculations indicate that water influx has replaced approximately 92 per cent of the oil withdrawn; however, electrical analyzer studies and other work have indicated that the natural water drive will probably be inadequate to maintain the pressure above the bubble point at economical rates of production beyond about 1954. Should the reservoir pressure be permitted to fall uncontrolled below the bubble point, it is likely that gas/oil ratios will increase and the resulting loss of gas from the reservoir will cause a loss in ultimate oil recovery.

Consequently the Redwater operators have under consideration a large scale pressure maintenance program by which they propose to inject fresh water from the North Saskatchewan River into the water-bearing portion of the reef underlying the oil reservoir. With such a program it is estimated that about 50 per cent or 700,000,000 bbl of oil can

Continued on Page 7, Section 2

MID-CONTINENT SECTION OFFICERS for 1952-53 are picture above as they gather for the regular Section meeting at the Tulsa Club. Front row, L to R: Roy H. Smith, executive committee and past chairman; G. C. MacDonald, vice-chairman (program); Jack H. Beesley, chairman; M. B. Penn, vice-chairman (membership and publicity); S. F. Byrd, secretary-treasurer; J. N. McGirl, executive committee and retiring chairman. Back row, L to R, are executive committee members J. A. Murphy, F. H. Callaway, W. B. Davis and E. H. Nielsen. Not pictured is F. H. Poettmann, executive committee.

"The Influence of Permeability on Ore Distribution in Limestone and Dolomite"

An article by Ernest L. Ohle, Economic Geology, Vol. 46, pages 667-706 and 871-908, (November and December, 1951)

As Reviewed by Silvain J. Pirson
Stanolind Oil and Gas Co., Tulsa, Okla.

This series of articles starts out by an excellent review of factors which affect the measurements of specific permeability in rocks. It is of special interest in the low range of permeabilities where the Klinkenberg correction is of significance. The controversy over whether or not adsorption of the flowing fluid affects the measurements receives much attention. Although the writer takes no side in the controversy between Grunberg and Nissan on the one hand and Klinkenberg, Yuster and Calhoun on the other, he seems to weigh very heavily the opinion that adsorption is of importance and may be significant in the permeability of limestone which ranges from 10^{-7} to 10^{-4} md. This opinion is based on the stress placed in the observation that the equivalent liquid permeability observed by means of the Klinkenberg correction is always larger than obtained through a measuring liquid even when no apparent reactive minerals are present in the rock. However, it is admittedly observed that it would be difficult to tell whether or not the difference is due to clay swelling or to mineral reactions.

The object of this series of articles and of the research upon which they are based was to find a correlation between the zinc sulfide ore distribution and the permeability of the various rock types in which this mineralization is found in the Eastern Tennessee District. A question to be elucidated was whether or not, at the time of deposition, certain rock sections presented preferential avenues of circulation to the mineralizing solution. A further point of investigation was to find out if certain rock types were more often mineralized than others and if these rocks could be distinguished on the basis of their permeability ranges.

As a result of more than one thousand measurements made on rock specimens in the east Tennessee mineralized district, the country rock could be divided into three main groups according to their range of permeability values. Original dolomite, with which ore is associated only when brecciated, had an average permeability of $8.1\ 10^{-4}$ md. This original dolomite is very fine grained (.02 mm) and sugary in appearance. It forms layers from a few inches to a few feet in thickness and is remarkably constant. Unaltered limestone, which is a very dense and fine grained rock and which also seldom carries mineralization, has an average permeability of $2.7\ 10^{-3}$ md, or slightly lower than original dolomite. Alteration of either the original dolomite or the unaltered limestone by the mineralizing solutions gives rise to the recrystalized limestones and dolomites, the average permeability of which is $5.9\ 10^{-1}$ md. This tremendous increase in permeability over the original rocks is due to an increase in grain size and to a more uniform texture of the rock. The author traced a progressive increase in permeability, observed in the recrystallized rocks, to the degree of dolomitization which may be ascertained by means of magnesium assay.

The author comments on the various mineralization theories which have been propounded in the literature to explain the formation of ore deposits and he concludes it is unnecessary to call upon mineralizing vapors of low viscosity but that the hydrothermal origin of zinc sulfide deposits or mineralization by hot solutions is sufficient because highly concentrated solutions are unnecessary in order to achieve the observed ore concentrations in view of the large volumes which may circulate over geologic time. The author relates a calculation of the volumetric flow of mineralizing solutions which is expected to circulate through a rock section 1,000 ft in length, 100 ft in width and 20 ft in height over a period of one million years. The flow is assumed to take place over a differential pressure of 100 atmospheres through a permeability of 10^{-2} md. Although the author made an error by a factor of nearly 100 in the computations and the resulting flow rate should be a $6.9\ 10^{-6}$ tons, the error is not deemed serious to the argument in favor of a mineralizing solution of low concentration. The mechanism of mineralization visualized by the author would be as follows:

1. Dolomitization of the country rock by the mineralizing solutions with a resulting increase in permeability.
2. Circulation of a sulfide bearing mineralizing solution and deposition of zinc sulfide in the sections of the country rock previously dolomitized and as a result of the presence of a permeability barrier offered by the non-affected rock.
3. The mineralizing solution depleted of its sulfides would move out without traces or without materially affecting the country rock any further. This escape of the depleted solution would have to take place through rocks of much lower permeability, but this is not a difficulty of the proposed mineralizing mechanism because the available cross-sectional area of escape is much larger than the cross-sectional area perpendicular to the direction of solution flow in the mineralized high permeability sections.

The significance of the study from an ore deposition point of view resides mainly in the explanation of the mineralization of low permeability rocks and in the justification of the zonal distribution of metallic elements around mineralization centers or batholiths. The zonal distribution of the elements has been observed to be according to ionic size and the elements which have the smallest ionic radius (heavy elements) are also those which travel the farthest from the mineralization centers and which require the rocks of lowest permeability in order to strain them out and precipitate them in the form of an ore deposit.

Although the process of oil origin is unknown, it is possible to speculate on the significance of this study from the point of view of oil accumulation and migration. Whatever the process of oil formation is, it is possible to visualize oil field waters as the mineralizing solutions carrying the "oil mother substance" whatever it may be (organic acids, colloidal suspension of organic matter, oil droplets, etc.) and moving through the sediments, first through the source bed, then through the reservoir rock where the oil is strained and screened from the solution by means of permeability barriers, such as shales. Possibly, in limestone country, the circulating solutions are also dolomitizing, in order to increase the rock permeability at first and then mineralizing afterwards. The above views on the possible mechanism of oil field formation may also be the explanation of oil field water salinity variations by straining the ions from the circulating ground waters at the shale barriers provided by the cap rocks. Accordingly, it would be unnecessary to call upon the underground evaporation of oil field waters in order to explain their greater salinity in the center of sedimentary basins. The process of oil field formation visualized here also lends weight to the geochemists' contentions of alteration of the country rock by the formation of an oil field, which alteration is presumably reflected in the form of a mineralized halo. ★ ★ ★

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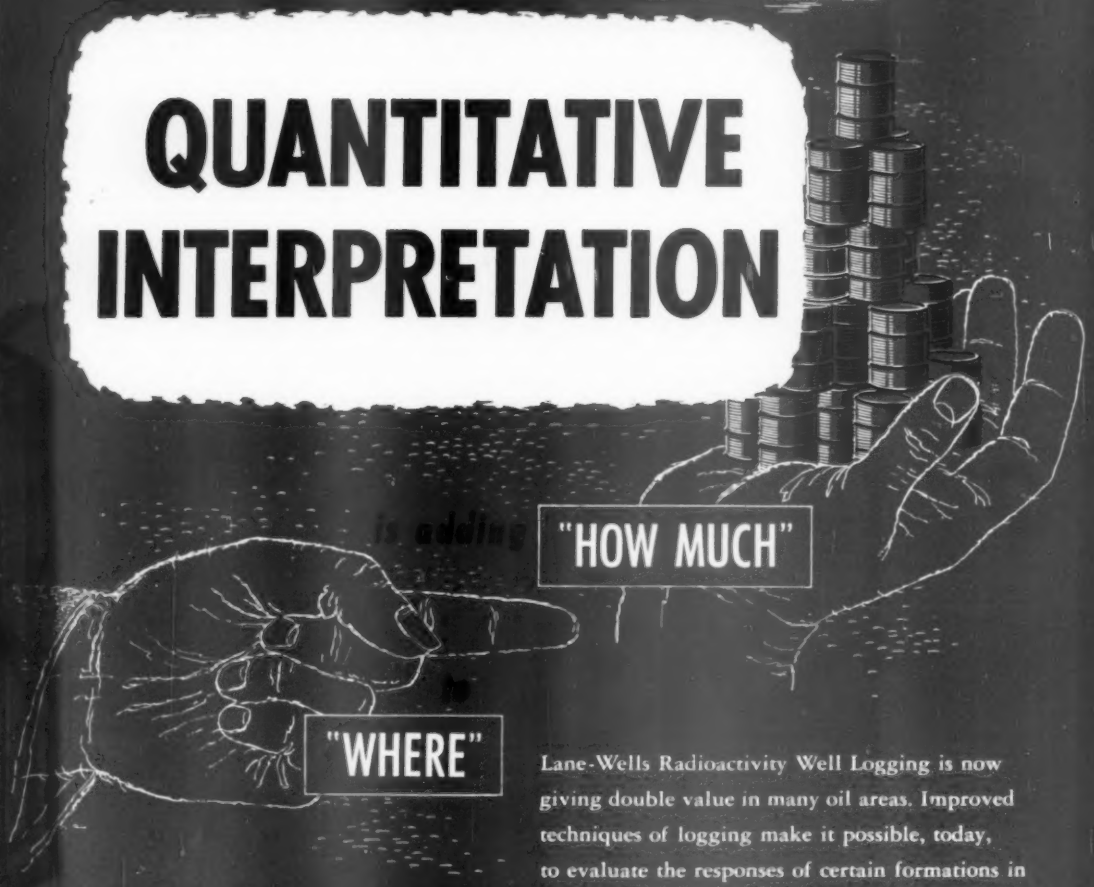

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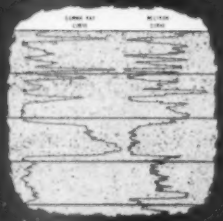

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VISUAL EXAMINATIONS OF FLUID BEHAVIOR IN POROUS MEDIA—PART I

ALFRED CHATENEVER, UNIVERSITY OF OKLAHOMA, NORMAN, OKLA.; AND **JOHN C. CALHOUN, JR.,** PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PA., MEMBER AIME

ABSTRACT

An exploratory study was made to examine the possibilities of a visual approach in investigations into microscopic mechanisms of fluid behavior in porous media. Appropriate apparatus and techniques were developed so that microscopic phenomena could be recorded on color movie film as well as be observed visually. The observation flow cells in which the fluid behavior studies were made were essentially single-layered matrices of spheres between plates, sometimes all-glass, sometimes all-Lucite and sometimes a combination of the two. The fluids were limited to water and a filtered crude oil.

Two flow regimes were observed during the flow of the immiscible liquids: channel flow and slug flow. In the former, transport was effected through stable networks of interconnecting channels; and in the latter, part of the movement took place in the form of slugs. Under certain conditions, flood-front patterns were found to be different depending upon which liquids were the displacing and displaced phases and not depending upon whether the matrix was water-wet glass or oil-wet Lucite. Residual formations of oil and water were observed and are described. Some of the ramifications and significance of the observed phenomena are discussed.

INTRODUCTION

In recent years considerations of microscopic mechanisms of fluid flow in porous media have taken on greater significance. Much needs to be learned before the fundamentals of petroleum technology are completely established. For example, many unanswered questions exist in connection with relative permeability, displacement phenomena, residual fluid formations, flow structure, etc.; and further analytical mathematical formulations are seriously indicated. It is hoped that systematic investigations into the microscopic mechanisms connected with the behavior of fluids in porous media will shed some light on some of the problems extant.

Until recently microscopic mechanisms have been considered almost exclusively as speculative hypotheses. Within the past few years, however, the problem has been submitted to a limited number of experimental investigations. Nuss and Whiting[1] made some studies on the pore-space geometry of sandstones and limestones by impregnating cores with an inert plastic and leaching the solid matrices to leave behind plastic models of the pore spaces. Schaefer[2] traced pore spaces microscopically through lengths of limestone cores by cutting away thin sections from the exposed faces normal to the line of view.

In 1949 two projects were organized in which dynamic flow phenomena were examined microscopically to uncover microscopic mechanisms. One was set up at the Pennsylvania State College where Lowman[3] observed heterogeneous fluid flow phenomena in capillaries. The second was the American Petroleum Institute Research Project 47B at the University of Oklahoma, where microscopic studies of dynamic fluid phenomena in synthetic porous matrices have been made by visual observation and cinephotomicrography.[4] It is with the latter that this paper is concerned, treating the techniques involved and the observations made.

TECHNIQUES

Observation Flow Cells

The observation flow cells formed a focal point in the techniques employed. Essentially, these were matrices composed of a single layer of spheres sandwiched between two flat plates. This design was arrived at after a series of pre-

[1] References given at end of paper.

Manuscript received in the office of the Petroleum Branch, AIME, May 21, 1951. Paper presented at the Petroleum Branch Fall Meeting in Oklahoma City, Okla., Oct. 3-5, 1951.

The movie film which records studies reported in this paper is available from the offices of Elmer O. Mattocks, American Petroleum Institute, 50 West 50th St., New York, 20, N. Y.

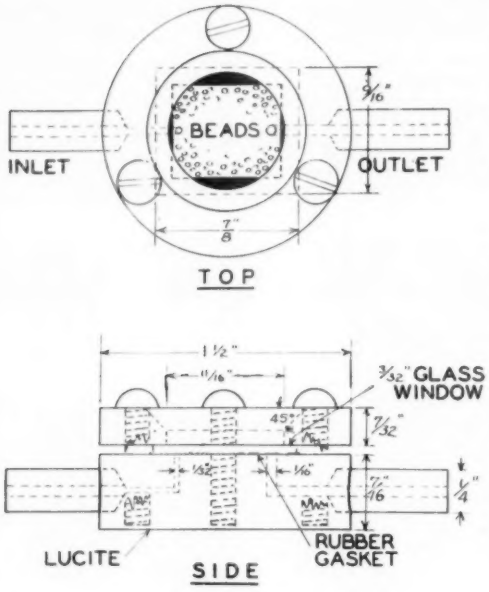

FIG. 1 — TYPE "B" CELL.

liminary investigations. It has been found that in multi-layered cells it was extremely difficult to differentiate one phase from another and the observations of flow phenomena were almost hopelessly complicated. For matrices that were opaque, it was impossible to carry out continuous microscopic observations through the depth of the beds. Thus a single-layered matrix, composed of glass spheres where possible, was decided upon as the structure most likely to produce easily observed flow phenomena despite its highly ideal nature. Flow phenomena established in this way would then provide a basis for further studies in more natural systems.

Two types of flow cells have been used. The first of these is the Type B cell of which a typical example is diagrammed in Fig. 1. The four principal parts of this cell are the base, the compression cover, the observation window and the gasket. The diagram is explicit with regard to the functions of the different components.

The base in all cells of this type was either wholly or principally Lucite. It was prepared from a Lucite cylinder (1½-in. diam. and 7/16 in. height) that was molded from molding powder at 140°C and 3,000 psig. The dimensions and shape, which in turn determined the dimensions and shape of the rest of the cell, were dictated primarily by the more ready availability of the molding equipment involved. In the diagram two ports are shown. These could be changed in number and position at will. Tubing connections were either cemented in as shown or threaded in. In those cases where it was desired to make an all-glass matrix composed of a glass top, glass spheres and a glass base, a glass plate was molded into the Lucite base in a press. This was done by pouring the requisite amount of molding powder over the glass plate in a cylindrical mold and molding in an hydraulic press at 140°C and 3,000 psig. With the ports drilled in by means of a carbide milling cutter type burr, this plate served as the base for the all-glass cell.

The compression ring, by means of which force was brought to bear against the sealing gasket through the observation window, was made of Lucite as diagrammed or aluminum. The Lucite rings were cut from molded Lucite discs. The aluminum rings were machined and could be prepared slightly thinner. The observation window served as the top wall of the matrix and provided a means for observing the phenomena. It was limited in thickness by the working distance of the microscope objective under which it was to be used. In general, the thicker glass windows were less liable to breakage and buckling than were the thinner ones. For all-Lucite matrices requiring a Lucite top wall, a thin Lucite disc was used backed up by a glass window. In this way the undesirable optical properties of the Lucite were reduced to a minimum and the necessary rigidity was maintained. The gasket was usually cut from rubber commonly found in toy balloons.

Before assembling any of the cells all but one port were first plugged up with 150-mesh screens to keep the spheres from flowing out. Then the gasket was placed in its proper position and covered by the observation window and compression ring. With the components in place, the compression screws were turned down evenly until the cell bed was of the desired depth (0.0075 in.). The spheres used to fill the flow beds were carefully screened so as to be uniform in size (0.007 in.). They were introduced through the free port and packed into place by the use of an air stream, tapping and vibration. In this way single-layered cells closely approximating a rhombic pattern of packing were attained.

The second cell design that found wide use was the Type C cell of which a typical example is shown in Fig. 2. The component parts are quite similar to the corresponding parts in

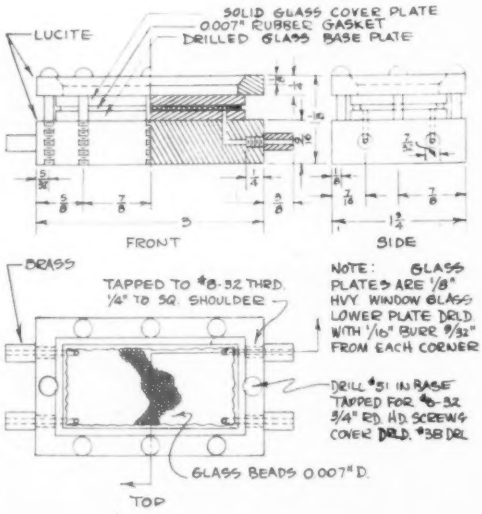
SOLID GLASS COVER PLATE
0.007" RUBBER GASKET
DRILLED GLASS BASE PLATE
LUCITE
FRONT
SIDE
BRASS
TAPPED TO #8-32 THRD. 1/4" TO SQ. SHOULDER
NOTE: GLASS PLATES ARE 1/8" HVY WINDOW GLASS LOWER PLATE DRLD WITH 1/16" BURR 9/32" FROM EACH CORNER
DRILL #51 IN BASE TAPPED FOR #8-32 5/4" RD. HD. SCREWS COVER DRLD. #38 DRL
GLASS BEADS 0.007" D.
TOP

FIG. 2 — TYPE "C" CELL.

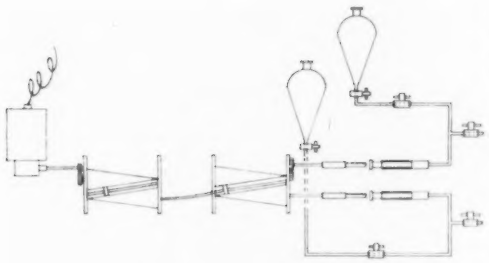

FIG. 3 — PUMPING APPARATUS.

the Type B cell except for shape and size. The greatest difference lay in the structure of the base. In most instances, the base was made in two pieces as indicated in Fig. 2. For all-glass cells aluminum was most often used for the framework holding the inlets and outlets. The other material that found some use was Lucite. With aluminum it was necessary to cut a window to permit the use of transmitted light for the examinations. The Lucite framework could be used in its solid form. For an all-glass cell, the lower plate of the flow bed was simply a plate of glass with holes drilled through it to match those of the inlets and outlets in the framework. Where a sealing aid was required to prevent leakage between the plate and the framework an inert lacquer was used. In those cells requiring a Lucite plate on the bottom of the flow bed, a one-piece solid Lucite base was used.

The gaskets, upper plates and compression frame were functionally the same as with the Type B cell. In addition to rubber, lead foil was used for gaskets in these designs. The cells were assembled and filled with the same spheres and in the same manner as were the Type B cells. The principal advantage offered by this design was a much larger observable flow bed.

Positive displacement pumps provided the means of moving the fluids through the cells. One pumping system was constructed as diagrammed in Fig. 3. With this apparatus, two liquids could be pumped through hypodermic syringes which were activated by micrometer heads. Each micrometer head was rotated by the shaft of one of two cones placed base-to-apex and driven by a common friction pulley. By positioning this pulley along the length between the cones, different flow ratios could be established between the two fluids. The pulley in turn was driven by a motor at the various desired speeds. A second system was composed of Zenith gear pumps, one for each fluid, driven through Revco variable speed reducers.

Since the flow beds were packed with uniformly dimensioned spheres, the cross-sectional pore area available for fluid flow was fairly uniform down the length of the bed. Basing calculations upon this cross sectional area and volume flows, it was estimated that the range of flow velocity lay between 1.5 and 2,000 ft per day.

Cinephotomicrography

Color cinephotomicrography proved itself to be an indispensible tool for studying as well as recording dynamic flow phenomena. A phenomenon on film could be examined in much greater detail than is possible in a single viewing through the microscope at experimental rates. The apparatus involved consisted of an appropriate microscope and accessories, a 16-mm movie camera, a beam splitter, an arc illuminator and an exposure meter.

The microscope used was a research type microscope with a substage condenser and mechanical stage. The mechanical stage was fitted so as to accommodate the observation flow cells. Objectives with magnifications up to 10X were used in conjunction with eye-pieces of 10X magnification. The stage was kept in a horizontal position and the illumination was reflected by a mirror up through the flow bed lying parallel to the plane of the stage. The techniques for properly aligning the optical illuminating systems for even lighting and undistorted image reproductions may be found in treatises on photomicrography.[5]

A camera that was found adaptable to this work was of the Bell and Howell G.S.A.P. type. This was motor-driven and accommodated a 50-ft, 16-mm film magazine. It was capable of taking pictures at a rate as high as 64 frames per second, but only speeds of 16 and 32 frames per second were employed. The camera was used with and without its lens. A special viewer was built so that the image in the focal plane of the camera could be observed for purposes of synchronization. This was simply an empty magazine fitted with a clear or ground glass in the film aperture, a magnifying glass to enlarge the image and a viewing aperture at the other end. When it was inserted into the magazine chamber with the camera shutter open, the image in the focal plane could be easily seen. The film used was Kodachrome, daylight type.

With this apparatus it was necessary to use a high-intensity source of illumination. A Bausch and Lomb 4.5-amp. a-c carbon arc illuminator was found to be practicable for this purpose. It produced sufficient illumination to take pictures at a speed of 32 frames per second and produced a picture on Kodachrome, daylight type film, free of chromatic aberrations and with good color fidelity. An undesirable feature of this instrument lay in its tendency to flicker and drift despite the spring-wound clockwork used on the carbon-feed mechanism.

A light meter was essential for the estimation of proper light intensities. One based on that of Clemens and Brar[6] using a phototube in an electronic circuit was employed. The circuit is given in Fig. 4. The phototube was covered with a light shield and fitted with a small window and adapter so that it could be used on the eyepiece of the beam splitter. This instrument is of the balanced circuit type operating on

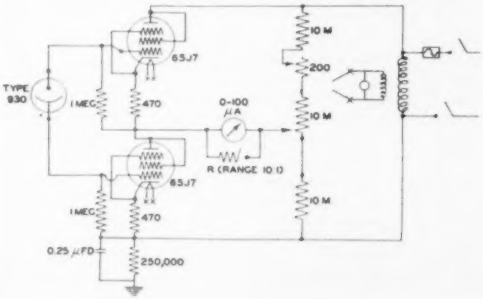

FIG. 4 — WIRING DIAGRAM FOR PHOTOTUBE EXPOSURE METER.

FIG. 5

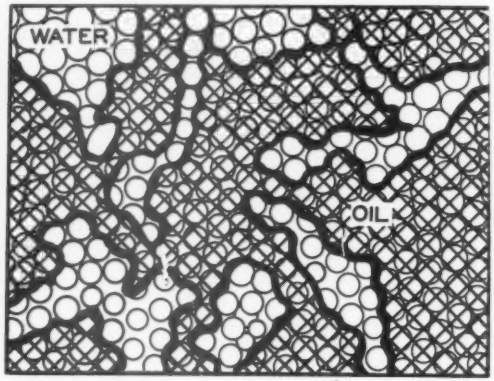

FIG. 5A

a 110-volt, 60-cycle line. The zero point is set by means of the variable resistance and potentiometer. The response follows from the disturbance in the balance caused by the phototube current. Calibration using a G.E. photo light meter as a standard showed the response to be linear with the intensity for a given source of illumination. For use in cinephotomicrography, the exposure meter was calibrated directly against film exposures.

OBSERVATIONS

Channel Flow

Channel flow is the name given to one of the flow regimes observed to prevail under certain conditions of simultaneous two-liquid flow. When water and crude oil (viscosity: 14 cp, specific gravity: 0.9, interfacial tension with water: six dynes/cm) were pumped through the observation flow cells at total velocities up to 1,000 ft per day, they were observed to move in channel flow.

This regime has several characteristics by which it may be described. Each fluid effects transport through its own network of interconnecting channels. The channels might vary in diameter from about one grain diameter to many. They are bound by liquid-liquid interfaces as well as liquid-solid surfaces and meander tortuously through the flow bed. It is probable that with the flow cells described above, each of the two flowing systems was transported through a single continuous network of channels.

For steady flow conditions, the channels maintained fixed geometries and positions throughout the flow bed. No movement was observed at the liquid-liquid interfaces at magnifications as high as 100X. With a change in saturation, the geometries of the channels were altered. An increase in oil saturation with a simultaneous decrease in water saturation was accompanied by a general growth in the diameters of the oil channels and a reduction in those of the water channels. There was a tendency for the channels to hold their positions in the flow bed. In the case of temporary flow disturbances the flow channels exhibited an elasticity whereby they tended to resume almost their exact starting configurations with the re-establishment of the original steady conditions.

By observing the movement of particles suspended in the flowing fluids, it was seen that the flow within any channel was essentially streamlined in nature. The moving particles delineated smooth lines of flow devoid of eddy currents despite the tortuosities of the channels. This was the type of behavior that was also observed in the flow of homogeneous fluids.

A photomicrograph showing a portion of the channel flow structure established in an observation flow cell is given in Fig. 5.* The oil and water channels are indicated in the photographs. They are distinguishable from each other by a difference in the darknesses occurring on either side of the

*A diagrammatic tracing of the photograph in Fig. 5 is given in Fig. 5A.

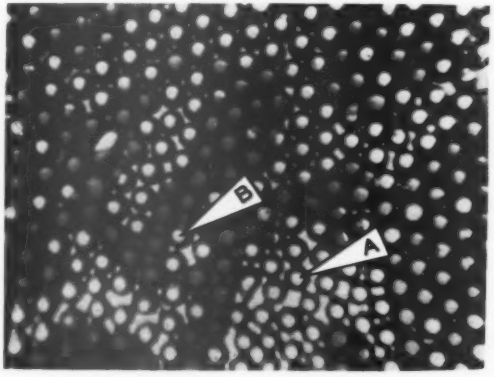

FIG 6

FIG. 7

oil-water interfaces. This is only that small portion of the flow bed included in the microscopic field. The matrix is an all-glass cell of a single layer of spheres (0.007 in. diam.) and the simultaneously flowing fluids are water and crude oil. The flow velocity of each of the fluids is about 350 ft per day. This phenomenon has been observed in other matrices including all-Lucite cells, glass-Lucite cells, and double-layered cells, as well as with other fluid systems including refined oils and brines with flow velocities ranging from 1.5 to 1,000 ft per day and flow ratios from 1:3 to 3:1.

Slug Flow

With a system composed of an all-glass observation flow cell flowing oil and water at less than 1,000 ft per day as noted above, a channel flow regime prevailed. However, increasing the total flow rate while keeping the flow ratio constant resulted in a change at some velocity less than 2,000 ft per day to a new flow regime in which slug flow was in evidence. By this it is meant that some of the transport was effected in the form of separate, isolated slugs or globules.

In an all-glass matrix, the oil phase formed the slugs while the water phase remained continuous. Fig. 6 is a photomicrograph of a system under slug flow. This is the same system and the same field shown in Fig. 5. The fluids, however, are flowing at a velocity of about 1,500 ft per day at a 1:1 ratio. To indicate differences in the flow structure two spheres have been labeled A and B respectively in the two figures. It is to be noted that in each case the sphere is under oil in Fig. 5 but not in Fig. 6, indicating that those parts of the oil flow structure have moved or disappeared during the existence of the slug flow regime. This phenomenon has been observed over ratios ranging from 1:3 to 3:1 and in cells of more than one layer of spheres. With an increase in total velocity past the point of slug flow genesis the frequency of slug formation and the number of slugs in the flow bed increased. Characteristic of these systems is the ease with which an oil globule or slug coalesces with another body of oil upon collision.

Flowing the same liquids under the same conditions in all-Lucite matrices, the oil appears as the continuous phase and the water as the slug-forming phase. If water slugs or globules are introduced into an oil stream, they will persist in slug flow resisting coalescence throughout their transport across the flow bed even upon strong collision with other water bodies. A photomicrograph of such a system is given in Fig. 7. The solid matrix is an all-Lucite one composed of a single layer of Lucite spheres (0.007 in. diam.) between two Lucite plates. Arrows indicate moving water globules.

Flooding Phenomena

"Flooding," here, is the term used to describe those systems in which only one fluid is being pumped into the observation flow cell. In an all-glass cell having an arbitrary initial water saturation with oil filling the remainder of the pore volume,

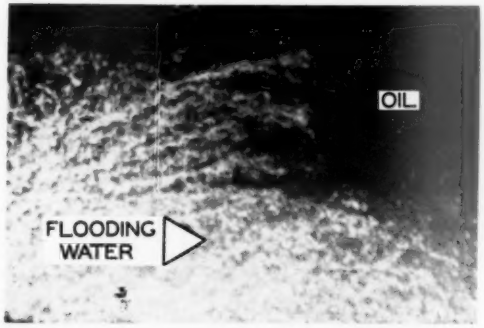

FIG. 8

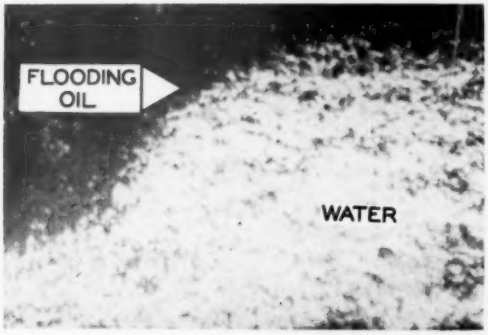

FIG. 9

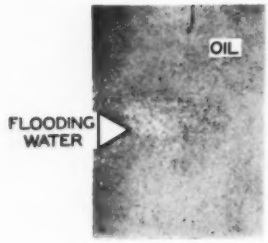

FIG. 10

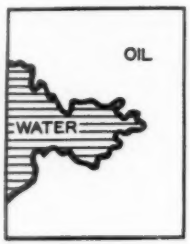

FIG. 10A

flooding with water results in a certain flood-front pattern. A stringy appearance is created by the water as it fingers through the flow bed, by-passing a considerable amount of oil. There is also a tendency for these fingers to branch out in dendritic patterns again by-passing oil.

A flood-front of this sort is shown in Fig. 8. This is a macroscopic view of an all-glass observation flow cell of a single layer. The velocity of water flow is about 1,500 ft per day. The dark areas are those occupied by oil while the light ones are those occupied by the flooding water. An arrow indicates the general direction of flood. The oil involved is the same as that whose properties are given above.

When a water-saturated cell is flooded with oil, a new type of flood-front pattern develops. In this case, the flood-front appears to be a circumferential band around the inlet port. This is seen in Fig. 9 where the system described in Fig. 8 is undergoing a flood by the oil at a velocity of about 1,500 ft per day. In a flood of this type the displacement mechanism appears to be more of a piston-like action with little tendency toward fingering and gross by-passing. It would be expected that this would result in more efficient displacements.

Floods were carried out with the same liquids in all-Lucite flow cells. These were of the same dimensions as the all-glass cells but presented a solid matrix or different surface properties, the Lucite being preferentially wet by the oil and the glass by the water under the conditions of the experimentation. Despite this difference, similar flood-front patterns developed as with the all-glass flow beds. Figs. 10* and 11 are photographs of a water flood and oil flood respectively in an all-Lucite matrix, both at velocities of about 1,500 ft per day. In all of these floods the transport of fluids took place through continuous phases without any formation of slugs.

Residual Formations

"Residual Formations" refer to those fluid formations left behind a flood front in the matrix of an observation flow cell. In water floods, the most apparent residual oil formations were those large volumes by-passed by the water. Depending upon conditions of flooding and the physical characteristics of the fluid system and porous matrix, these varied from very small to very large portions of the total void volume. They were continuous over many sphere diameters and sometimes over the length of the whole cell.

Almost always, smaller residual oil formations were also found in the flow bed. One form that these took is shown in Fig. 12. In this case the oil formation covering a few spheres has been left behind in flooding an all-glass matrix with water. Apparently held in place by capillary forces, these formations are not displaced by flooding rates as high as 10,000 ft per day. The liquids were the same in properties as those described above.

Another form of residual oil is shown in Fig. 13. This is a free spherical globule, usually no larger than a sphere of the matrix, occupying an insular region between the spheres. One of the interesting characteristics of these is that they are subject to rotation in place during water flooding. Such rotation has been observed in globules that were not entirely free but attached to some solid surface in the matrix. For a given globule, the rotation was always in the same direction even

*A diagrammatic tracing of the photograph in Fig. 10 is given in Fig. 10A.

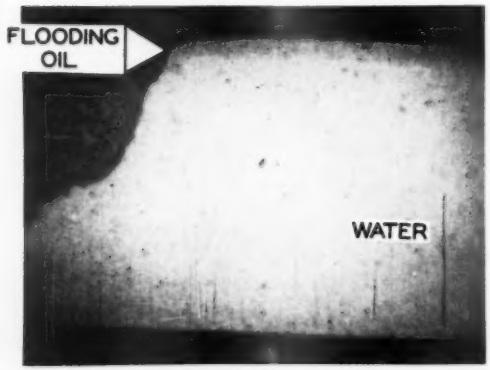

FIG. 11

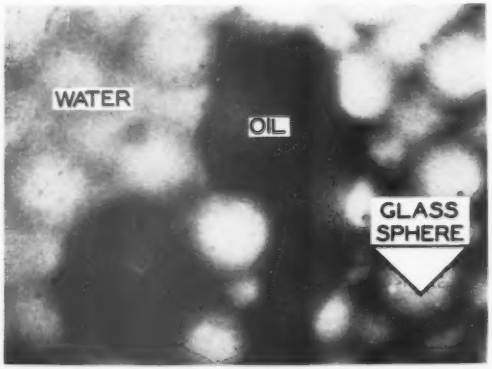

FIG. 12

FIG. 13

with intermittent water flooding. While a larger flooding velocity produced a higher speed of rotation, the velocity of the rotating globule appeared to be somewhat smaller than that of the flooding water. Some of the residual oil also remained behind in similar globules, smaller than the spheres of the matrix, which were attached to surfaces in the funicular regions and in which rotational movement was not observed.

In all-glass flow cells accommodating oil and water as described above, the predominating formation for the residual water was that of pendular rings. Most clearly observed were those that formed between the horizontal plates and the spheres of the flow matrix. However, they were found to form in a perpendicular plane between the spheres as well. Fig. 14 shows the intermediate step in the form of a "figure 8" as well as the final pendular rings formed during an oil flood. By suspending fine oil globules in the water phase, rotational movement has been observed in these pendular formations during flooding by oil.

In displacing water by oil in an all-Lucite flow cell, residual water remained behind as globules in the funicular regions rather than as pendular rings. Fig. 15 is a photograph of such formations in a single-layered Lucite matrix. These residual water formations were similar to some of the residual oil formations in all-glass cells during water floods.

DISCUSSION

These studies were, for the greatest part, exploratory in examining the possibilities of the visual approach in the investigation of microscopic mechanisms for fluid behavior in porous media. It is evident that with the development of the necessary techniques this approach is applicable to experimental systems which are somewhat idealized. Within such systems, as against more natural systems, some phenomena can be examined with considerable clarity and thoroughness leading to the eventual establishment of flow mechanisms for these particular systems. The most obvious idealizations are the single (or double) layer, the regular and uniform solid matrix, the use of flat plates in the flow bed and the use of processed fluids. Thereby, probable mechanisms are arrived at for natural systems which will grow in significance with the extension of investigations into systems more truly representative of petroleum reservoirs. Studies such as those described in this paper indicate a direction for such experimentation and further simplify the problem in providing definite phenomena to look for.

Channel flow as observed in the observation flow cells is consistent with developments in other directions. Rapoport and Leas[3] arrived at mathematical expressions defining the limits of liquid relative permeability in a liquid-gas system based on the postulation that the flow regime is that of channel flow or "parallel flow" as they term it. Comparing experimental data with theory they find satisfactory agreement.

In a paper by Geffen, Owens, Parrish and Morse[4] two points are of interest in this connection. Their saturation profiles for any one oil-water flowing ratio are different for different pressure gradients. However, the shapes of the profiles for all the pressure gradients are generally similar for the one flowing ratio. The second point involves the effect of saturation history upon relative permeabilities. They find that at a given saturation of brine, for example in an oil-brine system, the oil relative permeability curve is reversible with higher brine saturations. Upon reducing the brine to some lower value a new curve is arrived at which again is reversible but different from the previous curve. This hysteresis effect and the saturation profile variations may both be explained on the basis of a channel flow regime.

Wilson, Calhoun, and Chatenever[5] have found visual evidences of channel flow in synthetic cores. Flowing glycerine and melted paraffin through consolidated salt cores, and solidifying the wax, they found a flow structure composed of a network of interconnecting channels.

It is difficult to evaluate the significance of slug flow without additional data. The important factor in the genesis of slug flow is probably capillary pressure rather than velocity of flow. Further work is required in order to be able to estimate that portion of total flow that might be in the form of slug flow. It is indicated that in phases that tend to coalesce easily the slug flow regime will be less prevalent than in those where

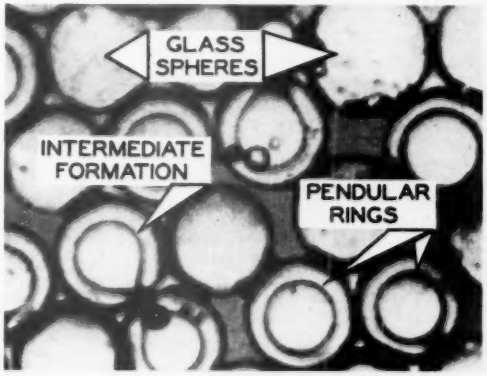

FIG. 14

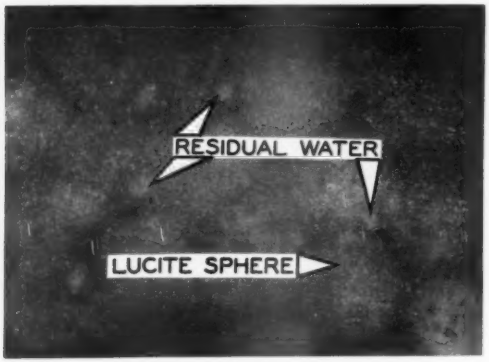

FIG. 15

there is a strong tendency not to coalesce. It is possible that this mode of fluid transport might have a bearing upon displacement phenomena as well as flow behavior. Thus, where by-passing is usually thought of in terms of sidetracking, a mechanism is introduced here in which a fluid may be by-passed by another flowing through it in globules or bubbles.

Of the flood-front patterns noticed in the flooding experiments, it would be expected that floods subject to the fingering mechanism would not be as efficient as those with regular linear fronts. It would be expected, too, that ultimate recoveries in the former case would be less although the relationships here are more subtle. As a consequence of the similarity of flooding behavior in glass and Lucite systems, preferably wet by water and oil respectively, it appears on the basis of these limited investigations that the wettability properties of the solid matrix may have relatively little effect upon the flood-front pattern. As a consequence of this, surface tension effects on flooding behavior might be relegated to a minor role. One relationship that suggests itself strongly in this connection is the ratio between the viscosities of the displaced and the displacing fluids. It is pertinent that flood-front characteristics have been studied here only over the length of a small observation cell; and it is possible that further ramifications may develop in cells of larger dimensions.

Most of the interest in residual oil formations derives from a desire to avoid them or, having formed them, to displace them. Again, it is as yet difficult to determine on the basis of these studies the relative importance of the various formations discussed. However, there are suggestions that any process that would favor the establishment of more numerous channels of flooding water would also favor smaller residual oil formations. It appears as if those that are given to rotation are probably the most difficult to displace by purely physical means. For those that are held in place primarily because of capillary forces, it would be expected that surface tension lowering agents would be efficacious in aiding displacement. Unlike the conditions attending flood-front phenomena, the wettability of the solid matrix is of definite consequence in residual formations. Thus in an all-glass water-wet cell none of the residual oil finds itself in the pendular regions. On the other hand, pendular rings are the most prevalent residual water formations in a matrix of this sort. This would be expected on the basis of Leverett's[10] work on capillary behavior. The movements within the pendular rings are noteworthy, as are those of the rotating oil globules in that they might have some bearing upon the dissipation of reservoir energies.

It is important to realize that the observations under discussion have been carried out in only a limited number of artificial systems. It is necessary, therefore, that the conclusions arrived at be confirmed by more extensive investigations before they are applied to natural petroleum reservoirs. One particular point that requires clarification, for example, is the apparent importance of surface tension in residual formations and the apparent lack of significance of this property in flood-front patterns. Current researches have already indicated significant possibilities and it is hoped that more work in this connection will be forthcoming.

ACKNOWLEDGMENT

The authors are grateful to the American Petroleum Institute for the support making this work possible and permission for its publication.

REFERENCES

1. Nuss, W. F., and Whiting, R. L.: "Technique for Reproducing Rock Pore Space," AAPG *Bulletin*, Nov., 1947.
2. Schaefer, W.: "Limestone Pore Space Study," a movie produced by the laboratories of Stanolind Oil and Gas Co., presented before Petroleum Division, AIME, Dallas, Tex., October, 1948.
3. Lowman, Q.: "Microscopic Studies of Capillary Flow," a film produced by the Petroleum and Natural Gas Department, The Pennsylvania State College, August, 1950.
4. Calhoun, J. C., and Chatenever, A.: "Microscopic Behavior of Heterogeneous Fluids in Porous Media," a series of films presented before annual American Petroleum Institute Meetings in Chicago, Ill., November, 1949; and Los Angeles, Calif., November, 1950.
5. "Photomicrography," Eastman Kodak Co., Rochester, N. Y., (1944).
6. Clemens and Brar: "Exposure Meter for Photography," A.E.D.D.-2271, Technical Information Branch, Oak Ridge, Tenn., AEC, Oak Ridge, Tenn., (1948).
7. Rapoport, L. A., and Leas, W. J.: "Relative Permeability to Liquid in Liquid-Gas Systems," *Trans.* AIME, (1951) **192**, 83.
8. Geffen, T. M., Owens, W. W., Parrish, J. R., and Morse, R. A.: "Experimental Investigation of Factors Affecting Laboratory Relative Permeability Measurements," *Trans.* AIME, (1951) **192**, 99.
9. Wilson, D. A., Calhoun, J. C., and Chatenever, A.: "A Visual Examination of Fluid Saturations in a Porous Medium," to be published.
10. Leverett, M. C.: "Capillary Behavior in Porous Solids," *Trans.* AIME, (1941) **142**, 152.

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DRILLING FLUID FILTER LOSS AT HIGH TEMPERATURES AND PRESSURES

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ABSTRACT

This paper discusses the results obtained from high temperature, high pressure filter loss studies in which field samples of clay-water, emulsion, and oil base fluids were used. High temperature, high pressure tests of some premium priced emulsion and oil base drilling fluids show filter loss peculiarities that are not predicted by standard API tests. It is recommended that high temperature, high pressure filter loss tests be used to evaluate the performance of such fluids.

Apparatus is described which proved to be satisfactory for evaluating filter loss behavior over a wide range of temperatures and pressures.

INTRODUCTION

The petroleum industry spends large sums of money each year on chemical treating agents for lowering filter loss and on premium-priced low filter loss drilling fluids.

While it is an accepted fact that low filter loss is advantageous during drilling operations, it is questionable whether the present standard method of determining filter loss gives a reliable indication of the loss to be expected under bottom hole conditions. The purpose of this paper is to show that high temperature, high pressure filter loss tests should be used to evaluate filter loss behavior of fluids for deep drilling.

Concern over possible effects of filter loss on oil well drilling and well productivity dates back to the early 1920's. During the years 1922 to 1924, filtration studies were reported by Knapp,[1] Anderson[2] and Kirwan.[3] These studies were the first to be reported in the literature on this subject. No further information was published on the subject until 1932 when Rubel[4] presented a paper in which he discussed the effect of drilling fluids on oil well productivity.

In 1935, Jones and Babson[5] constructed the first laboratory tester designed to study the effects of temperature and pressure on the filter loss behavior of clay-water drilling fluids. In a discussion of their investigations, Jones and Babson[5] stated, "Performance characteristics of a mud can be evaluated with considerable reliability by a single test at 2,000 psi and 200°F. Exact correlation between the results of performance tests made under these conditions and the behavior of muds in actual drilling operations is of course impossible." Jones and Babson apparently were well aware that at best laboratory tests can give only qualitative answers to the question of what is the actual behavior of a drilling fluid when subjected to deep drilling conditions. Jones[6] presented a paper in 1937 in which he described a static filter loss tester to be used for routine filter loss tests. This instrument subsequently was adopted as the standard API filter loss tester.

In 1938, Larsen[7] developed a relationship between filtrate volume and filtrate time that is in general acceptance today. Larsen was cognizant of the danger of estimating bottom hole behavior from filter loss measurements at room temperature. He tried to predict the effect of temperature on filter loss by relating temperature effects through the temperature dependence of filtrate viscosity. This was undoubtedly an over-simplification of the temperature dependence of drilling fluid filter loss.

In 1940, Byck[8] published a summary of experimental results of filter loss tests made on six representative California clay-water drilling fluids. He concluded that "no existing method will permit even an approximate determination of the filtration rate at high temperature from data at room temperature. It is necessary to measure filtration at the temperature actually anticipated in the well, or to make a sufficient number of tests at various lower temperatures so that a small extrapolation of these data to the anticipated well temperature may be applied."

Byck's findings were presumably well accepted and recognized by drilling fluid technologists, and yet, they did not lead to wide adoption of high temperature drilling fluid filtration equipment. This is evidenced by the fact that no additional information has appeared in print on the subject since 1940.

Study of Byck's data shows that there was a useful consistency in them. The fluids did not show predictable losses at high temperatures, but they did line up at high temperatures in approximately the same order that they lined up at low temperatures. That is, if a fluid appeared to be a good fluid with relatively low loss at low temperatures, it would also be a good fluid with relatively low loss at high temperatures.

In the last decade, the above situation has changed. The drilling fluid art is markedly different from what it was. The outstanding change, as far as the present discussion is concerned, has been the adoption of wholly new types of drilling fluids. Oil base and emulsion drilling fluids have come into wide use. It is, therefore, necessary to re-examine previously satisfactory generalizations to see if they are still valid.

It turns out, as might have been expected, that Byck's explicit generalization, already quoted, is still true. Filter losses at high temperatures cannot be predicted from filter losses at low temperatures. However, no further generalizations are valid now. Fluids of different chemical types show different general behaviors. No longer do the fluids line up approximately the same at high temperatures as they do at low temperatures. They may line up entirely differently. Special fluids exhibiting very low loss at low temperatures may have losses as high as those of ordinary clay-water fluids at high temperatures. This fact is highly significant, because premium prices are being paid for the special fluids.

[1]References given at end of paper.

Manuscript received in the Petroleum Branch office Oct. 4, 1951. Paper presented at the Fall Meeting of the Petroleum Branch in Los Angeles, Calif., Oct. 25-26, 1951.

The new types of fluids have invalidated the old generalizations, and it now seems time to urge (or urge again) that high temperature, high pressure filter testing methods be adopted throughout the drilling industry.

It is perhaps still true that the standard API filter test constitutes a good method for control of a single fluid in the field. As far as we know, it is still good practice to assume that when the surface-measured filter loss is going up, the bottom-hole loss is going up, and when chemical treatment lowers the surface-measured loss, the bottom-hole loss is lowered.

The thesis of this paper is that conventional filter tests are not satisfactory for comparisons of *different* fluids, particularly, if those fluids are of different types. The following sections describe apparatus and methods used to obtain high temperature, high pressure filter loss data. Experimental data are given from 141 tests of 18 different fluids.

APPARATUS

Apparatus used for determination of high temperature, high pressure filter loss behavior is pictured in Fig. 1. The apparatus consists of two identical filter units, each unit being a complete test instrument with individual temperature and pressure controls. Fig. 2 is a schematic diagram showing the essential features of one of the units.

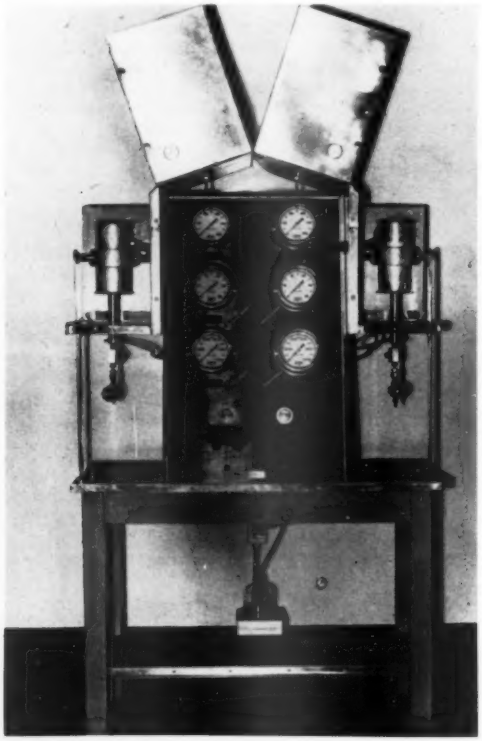

FIG. 1 — APPARATUS FOR DETERMINING HIGH TEMPERATURE, HIGH PRESSURE FILTER LOSS BEHAVIOR.

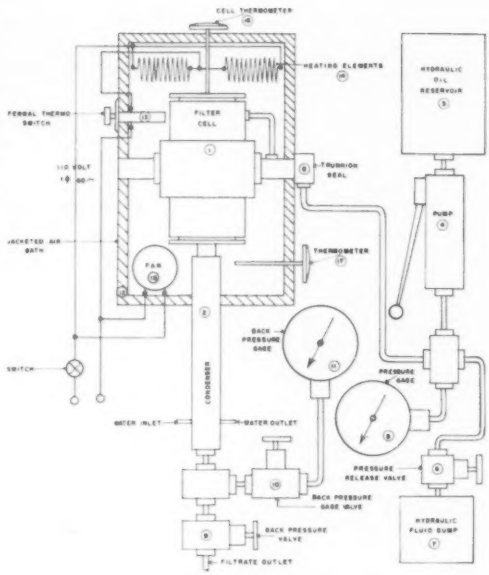

FIG. 2 — SCHEMATIC DIAGRAM OF HIGH TEMPERATURE, HIGH PRESSURE FILTER LOSS UNIT.

The filter cell (1) shown in Fig. 2 consists of a cylindrical shell pivoted on trunnions in such a fashion that either end of the shell is accessible for attachment of other parts and for cleaning. Each end of the shell is threaded so that top and bottom plate assemblies may be fastened to the shell. The bottom plate, which is the filter plate assembly* is held in position inside the cylindrical shell by a threaded clamp ring. The top plate is held in position inside the cylindrical shell by a threaded clamp ring which is an integral part of the top plate. Both the filter plate and the top plate are fitted with O-rings that act as pressure seals.

A removable condenser (2) is attached to the bottom side of the filter plate assembly. The condenser is necessary to prevent filtrate vaporization when tests are made at high temperatures.

The pressure system consists of a hydraulic fluid reservoir (3), a hand-operated hydraulic pump (4), a pressure gauge (5), a pressure release valve (6), and a hydraulic fluid sump (7). These items are connected by pressure tubing as shown.

In normal operations, hydraulic fluid (white oil) is pumped from the reservoir (3) through a trunnion seal (8) into the filter cell (1). Fluid enters the filter cell through the wall of the cylindrical shell at a point directly below the top plate assembly. Pressure is indicated by pressure gauge (5). Pressure may be released by opening valve (6), which allows the pressured hydraulic fluid to escape into the fluid sump (7). Pressures up to 5,000 psi can be maintained in routine tests.

Associated with the hydraulic system is the back pressure system, which is attached to the bottom end of the condenser

*Patent applied for, licensed to Oil Base, Inc., Compton, Calif.

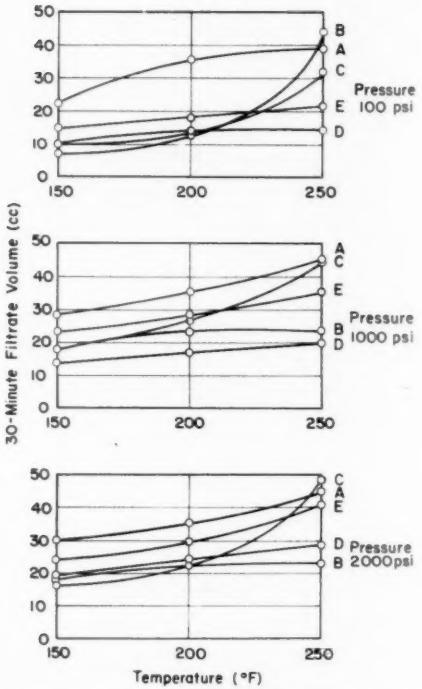

FIG. 3 — EFFECT OF TEMPERATURE ON FILTER LOSS OF CLAY-WATER FLUIDS.

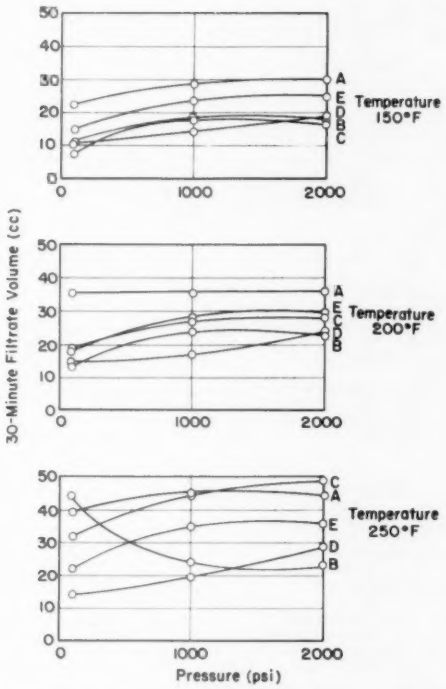

FIG. 4 — EFFECT OF PRESSURE ON FILTER LOSS OF CLAY-WATER FLUIDS.

(2). The back pressure system consists of a back pressure valve (9), a back pressure gauge valve (10), and a back pressure gauge (11), all of which are connected by pressure tubing as shown. Back pressure is regulated by operation of valve (9).

The filter cell (1) and the upper end of the condenser (2) are enclosed in an insulated, thermostatic air bath (12). Temperature is controlled by a Fenwal thermoswitch (13), fin-type electric heating elements (14) and a circulating fan (15). Filter cell and thermostat temperatures are measured with Weston dial thermometers (16) and (17) respectively. Temperature may be controlled from room temperature to 350°F.

EXPERIMENTAL METHOD

Prior to using the cell for test purposes, the bottom plate assembly, consisting of the filter plate and condenser, is flooded with liquid to make filtrate hold-up negligible. As a result, filtrate errors never exceed 1 cu cm. Water is used to flood the assembly for clay-water and emulsion fluid tests, and oil is used for oil base fluid tests. Flooding is accomplished by attaching a fluid reservoir to the lower end of the condenser. Once the assembly is filled, the back pressure valve (9) is closed and the fluid reservoir is disconnected from the end of the condenser. Excess fluid is wiped from the filter plate surface. Two sheets of fluid-saturated Whatman No. 50 filter paper are placed on top of the filter plate and are held in place by a clamp ring. After the bottom plate assembly is flooded and the filter paper is clamped to the upper surface of the filter plate, the assembly is locked in position inside the filter cell cylindrical shell by the lower clamp ring. Drilling fluid now may be poured into the cell.

After the drilling fluid sample is mixed for 30 minutes, approximately 425 cu cm of the sample are poured into the filter cell. The remaining free space above the sample is filled with hydraulic fluid (white oil) and the cell is closed. The air thermostat (12) is closed and thermometers (16) and (17) are inserted in their proper locations. Pressure is applied to the cell by use of hydraulic pump (4) until the desired pressure is reached. Fenwal thermoswitch (13) is set to the desired temperature and heating elements (14) are turned on. A rotary selector switch (not shown) controls the rate of heating by selecting the proper combination of heating elements. Pressure is maintained constant during the heating interval. Water is circulated through the condenser jacket. Once the desired temperature is reached, the back pressure valve (9) is opened sufficiently to develop the desired differential pressure across the filter cake. Filtrate is collected in a graduated cylinder which has been placed beneath the end of the condenser. Filtration time is recorded from the instant the back pressure valve (9) is opened. Pressure is maintained constant throughout the test. When the test is completed, pressure release valve (6) is opened and heating elements (14) are shut off. The filter cell is allowed to cool before it is opened for filter cake inspection and cleaning.

Filter loss is determined by the quantity of filtrate collected in 30 minutes. Occasionally the 30-minute reading is incorrect

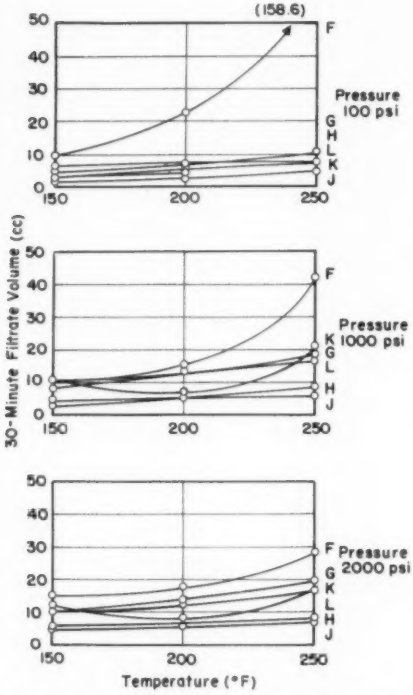

FIG. 5 — EFFECT OF TEMPERATURE ON FILTER LOSS OF EMULSION FLUIDS.

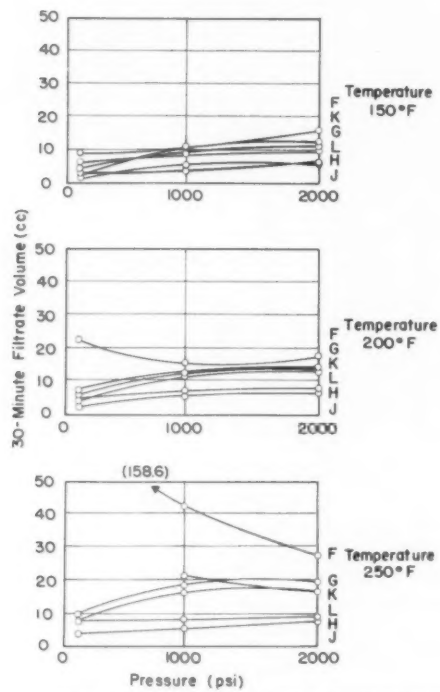

FIG. 6 — EFFECT OF PRESSURE ON FILTER LOSS OF EMULSION FLUIDS.

because of minor variations in flooding the bottom plate assembly. The magnitude of the error may be determined by extrapolating the filtrate-volume-*vs*-square-root-of-time curve to zero time. The intercept on the filtrate volume coordinate is a measure of the correction which must be applied to the 30-minute reading. This correction is never greater than 1 cu cm.

EXPERIMENTAL RESULTS

Filtration behavior of drilling fluids is influenced largely by the kind, concentration, and particle size of solids present in the fluids. Filtration rates are influenced by the dispersion of particles in the fluids, the hydration of the particles, the presence or absence of hydrated colloidal materials, and the presence or absence of dispersing or agglomerating chemicals.

Two steps involved in the process of filtration are (1) bridging of openings in the filter medium and (2) filtering of fluid through the filter cake that develops on the filter medium as filtration takes place. Drilling fluids which do not contain finely divided minerals will be unable to bridge the openings in filter media and will have poor filter loss properties. Of the three kinds of drilling fluids, clay-water, emulsion, and oil base; oil base drilling fluids are most likely to show poor filter loss behavior unless they have been used in a drilling well for sufficient time to acquire mineral fines. All drilling fluid samples used in this investigation were taken from drilling wells that had been drilling for considerable time.

Filter loss tests were made at 150, 200, and 250°F, and at differential pressures of 100, 1,000, and 2,000 psi. Differential pressures were used because independent tests showed that drilling fluid filter loss behavior is dependent more on differential pressure than on total pressure.

Clay-Water Drilling Fluids

Five different clay-water drilling fluids were tested. Table I presents the filter loss data obtained for each fluid. The data are plotted as filtrate volume *vs* temperature curves in Fig. 3 and as filtrate volume *vs* pressure curves in Fig. 4.

Examination of Fig. 3 shows that, at constant pressure, filter loss increases with increasing temperature. The change in filter loss with increasing temperature is non-linear and, in general, is different for each fluid tested. Fig. 4 shows that the effect of pressure on filter loss is unpredictable. At 150

Table I — Filter Loss Behavior of Clay-Water Drilling Fluids

Temp. °F	Pressure psi	30-Minute Filtrate Volume (cu cm)				
		A	*B*	*C*	*D*	*E*
150	100	22.6	7.5	11.6	10.8	15.0
	1,000	28.4	18.2	17.8	14.2	23.4
	2,000	30.0	18.2	17.0	19.0	24.4
200	100	35.6	13.0	18.8	14.0	18.0
	1,000	35.6	23.6	27.4	16.8	28.4
	2,000	35.6	22.6	28.0	23.6	29.2
250	100	39.0	44.4	32.2	14.0	22.0
	1,000	45.0	23.6	44.6	19.8	35.2
	2,000	44.6	23.0	48.4	28.6	35.6

Table II — Filter Loss Behavior of Emulsion Drilling Fluids

Temp. °F	Pressure psi	30-Minute Filtrate Volume (cu cm)					
		F	*G*	*H*	*J*	*K*	*L*
150	100	9.3	4.4	4.0	2.0	2.5	6.2
	1,000	11.2	10.2	4.2	4.8	11.0	8.4
	2,000	15.6	10.4	5.8	5.4	12.6	9.8
200	100	22.8	6.0	5.0	2.8	4.2	7.2
	1,000	15.2	13.2	6.8	5.6	7.4	12.8
	2,000	17.6	13.8	7.4	6.4	7.8	12.6
250	100	158.6	10.2	8.2	4.0	.....	7.7
	1,000	42.0	18.4	8.4	6.2	20.8	16.4
	2,000	27.8	19.4	8.6	7.6	16.6	16.6

Table III — Filter Loss Behavior of Oil Base Drilling Fluids

Temp. °F	Pressure psi	30-Minute Filtrate Volume (cu cm)						
		M	*N*	*O*	*P*	*Q*	*R*	*S*
150	100	8.6	0.4	0.5	1.0	1.4	0.0	0.0
	1,000	8.0	0.9	0.7				
	2,000	7.6	1.0	1.0				
200	100	16.4	0.9	0.6				
	1,000	14.8	2.2	0.8				
	2,000	28.2	2.4	1.3				
250	100	43.2	1.2	4.4				
	1,000	125.6	2.5	1.8				
	2,000	175.4	2.7	1.6				
300	2,425				1.7	4.6	8.6	232.0

and 200°F there is a tendency for filter loss to increase with increasing pressure, but at 250°F both increases and decreases in filter loss can be observed with increasing pressure.

Emulsion Drilling Fluids

Six emulsion drilling fluids were tested. Experimental data are presented in Table II. The data are plotted as filtrate volume *vs* temperature curves in Fig. 5 and as filtrate volume *vs* pressure curves in Fig. 6.

Examination of Fig. 5 shows that filter loss, measured at constant pressure, increases with increasing temperature. Fig. 6 shows that pressure effect on filter loss behavior is unpredictable.

Comparison of the filter loss behavior of clay-water and emulsion fluids shows that in many instances emulsion fluids break down at high temperatures and pressures. They then exhibit filter loss properties that are no better than those of ordinary clay-water fluids. This comparison shows the need for more complete testing of premium priced fluids. Apparently filter loss behavior cannot be predicted from a single low temperature, low pressure filter loss measurement.

Oil Base Drilling Fluids

Three oil base drilling fluids were tested at 100, 1,000, and 2,000 psi, and 150, 200, and 250°F. Four additional samples were tested at 100 and 2,425 psi, and 150 and 300°F. Experimental data are presented in Table III. The data obtained from tests of the first three samples are plotted as filtrate volume *vs* temperature curves in Fig. 7, and as filtrate volume

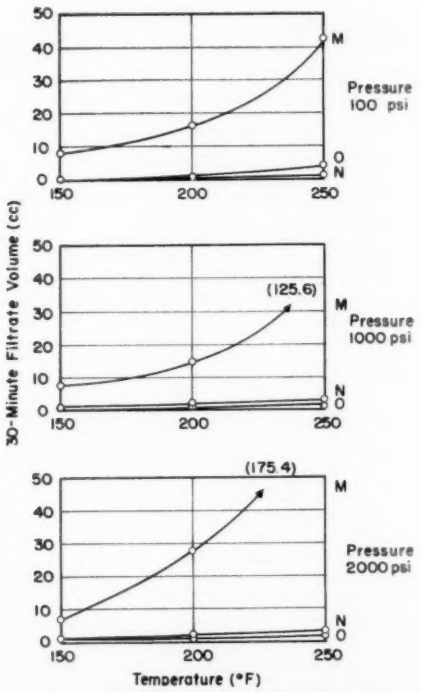

FIG. 7 — EFFECT OF TEMPERATURE ON FILTER LOSS OF OIL BASE FLUIDS.

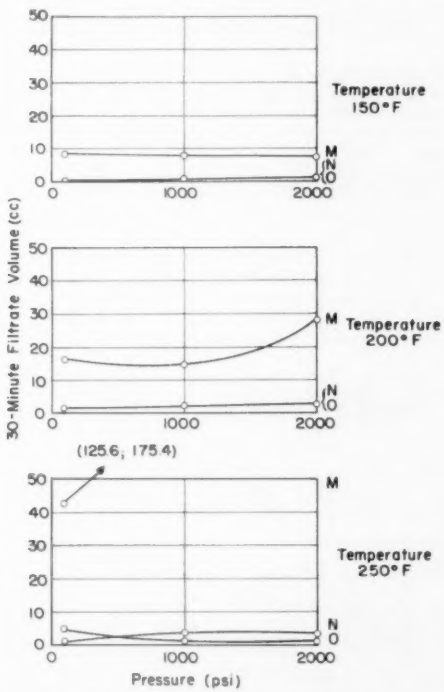

FIG. 8 — EFFECT OF PRESSURE ON FILTER LOSS OF OIL BASE FLUIDS.

vs pressure curves in Fig. 8. Data obtained from tests of the four additional field samples are plotted as filtrate volume *vs* temperature curves in Fig. 9.

Examination of Fig. 7 shows that filter loss increases with increasing temperature at constant pressure. Fig. 8 shows that pressure effects on filter loss behavior are unpredicable. Fig. 9 compares the filter loss behavior of four fluids tested at 100 and 2,425 psi, and 150 and 300°F. The curves show that filter loss increases with increasing temperature. The curves also show that fluid *S*, a premium-priced fluid, apparently has unusually low filter loss in standard tests and that it breaks down completely at high temperature and pressure; in fact, the filter loss of fluid *S* at high temperature and pressure is greater than that of the poorest clay-water fluid examined in these tests.

Comparison is made in Fig. 10 between the filter loss behaviors of an ordinary clay-water drilling fluid, as represented by fluid *D*, and of selected emulsion fluids. Examination of Fig. 10 shows that two emulsion fluids, *F* and *K*, exhibit filter losses at high temperatures and pressures which are as great or greater than the filter loss shown by the clay-water fluid, *D*. The behavior of a satisfactory emulsion fluid is shown for comparison.

Failure of some premium priced emulsion and oil base drilling fluids to maintain satisfactory filter loss values at high temperatures and pressures demonstrates clearly the necessity for making filter loss tests under conditions which simulate those actually encountered in deep drilling.

CONCLUSIONS

1. Bottom-hole filter loss behavior cannot be predicted from measurements at surface temperatures in the standard API tester.

2. The standard test may serve well to control the behavior of a single fluid in the field. It may be assumed that when the standard API filter loss is lowered, the bottom hole filter loss is lowered. But confident comparisons between different fluids cannot be made.

3. Some premium-priced fluids, which in the standard test appear to have unusually low filter losses, actually have as high losses as ordinary clay-water fluids under bottom-hole conditions.

4. Comparisons between the filter losses of different drilling fluids should be made at temperature and pressures approximating those under which the fluids will be used.

REFERENCES

1. Knapp, A.: "Action of Mud-laden Fluids in Wells," *Trans.* AIME, (1923) 1076. (Also *Mining and Metallurgy*, Dec. 1922.)

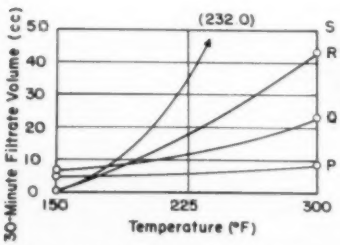

FIG. 9—EFFECT OF TEMPERATURE ON FILTER LOSS OF OIL BASE FLUIDS.

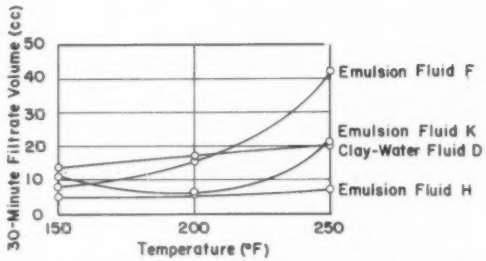

FIG. 10 — FILTER LOSS BEHAVIOR OF CLAY-WATER AND EMULSION DRILLING FLUIDS AT 1,000 PSI.

2. Anderson, H. H., in Burrell, L., Gaylord, E. G., Wagy, E. W., Case, J. B., Barnes, R. M., and Parsons, B. E.: "Committee Report to State Oil and Gas Supervisor, Summary of Operations, California Oil Fields," (1923) 8, (7), 60. *Cf.* ref. 4, 34.
3. Kirwan, M. J.: "Mud Fluid in Drilling and Production of Wells," *Oil Weekly*, (July 5, 1924).
4. Rubel, A. C.: "Effect of Drilling Mud on Production in California," API *Prod. Bull.*, (1932) **34**, 60.
5. Jones, P. H., and Babson, E. C.: "Evaluation of Rotary Drilling Muds," API *Drill. and Prod. Prac.*, (1935) 22.
6. Jones, P. H.: "Field Control of Drilling Mud," API *Drill. and Prod. Prac.*, (1937) 24.
7. Larsen, D. H.: "Methods of Determining the Filtration Characteristics of Drilling Muds," *Petr. Engineer*, (Sept., Nov., 1938). Also *Drilling Mud*, Baroid Sales Division, National Lead Co., (May, 1938).
8. Byck, H. T.: "Effect of Temperature on Plastering Properties and Viscosity of Rotary Drilling Muds," *Trans.* AIME, (1940) **136**, 165.

DISCUSSION

By J. M. Bugbee, Shell Oil Co., Houston, Tex., Member AIME

The authors are to be congratulated for a timely and useful contribution. Some additional remarks as to the bridging and filtration phenomena they mention may be helpful. Common filtration embodies two phenomena, the initial, generally minor one of the bridging of mud particles on the filter bed openings (the pre-bridging penetration of fines has been called the mud loss or mud spurt), and the major one of filtration. No one has yet derived a formulation which includes the two, although William and Cannon[1] attempted it. Larsen (Ref. 7 of text) sensed that the bridging could be, practically, neglected and his expression is for filtration alone. This is the reason that in making a Larsen-plot of filtration values for a test even where every precaution has been observed to properly flood the base plate assembly that a 0-intercept is rarely secured. A 0-intercept would indicate that bridging and the initiation of filtration occurred simultaneously. This is worthy of emphasis for fine-particle bentonite, starch and oil-base muds prepared in the laboratory lack the coarse particle range necessary for bridging on coarser filter media such as actual sands. As the authors state, however, a short period of use in a well generally supplies coarser mineral particles for bridging and the mud loss then becomes minor.

REFERENCE

1. Williams, M., and Cannon, G. E.: "Evaluation of Filtration Properties of Drilling Muds," API *Drill. and Prod. Prac.*, (1938) 13.

★ ★ ★

EXPERIMENTAL EVALUATION OF WELL PERFORATION METHODS AS APPLIED TO HARD LIMESTONE

HENRY LEWELLING, THE ATLANTIC REFINING CO., DALLAS, TEX., MEMBER AIME

ABSTRACT

An experimental investigation of the relative effectiveness of standard bullets and "shaped charges" in perforating dense, hard formations is reported. A method is described which simulates the conditions under which a shot is normally fired. Results are evaluated on the basis of depth of penetration, extent of fracturing, extent and nature of formation damage, and other physical characteristics.

INTRODUCTION

A study was made of the relative merits of bullets and "shaped charges"* as applied to well completions in hard, dense formations such as those encountered in the Permian Basin. The planning of the laboratory program stipulated that core samples should be prepared and mounted in such a way that perforation shots of either kind** could be fired into them, keeping the factors pertinent to good shooting practice similar to what they would be in a well.

The shooting was done in a buried tank, with the sample and shooting equipment covered with water. The depth of water was calculated to be sufficient to simulate the inertial effects of well fluids for the duration of an explosion (a few micro-seconds).

Flow measurements were attempted on the specimens after perforation. Due to the lack of uniformity of the limestone, shale breaks, etc., these measurements proved to be of little value to the study. The mounting materials were removed, so that the character of the penetration, fracturing, etc., could be observed.

METHOD

Laboratory samples were selected from the hard, dolomitic sand cores from Block 31 Field. Core pieces having a $3\frac{3}{4}$ in. diameter and a useful length of 10 to 12 in. were used. Selection was aimed at those pieces having a minimum of shale streaks and other irregularities. The ends were cut off square with the diamond saw. Prior to being mounted, the cores were soaked in water to prevent them from absorbing water out of the wet concrete, thus weakening it.

A set of steel capsules was fabricated for holding the core samples. Seven-in. casing was cut in two-ft lengths, of which one end was closed by "orange-peeling" and welding, and the other was threaded to accept a standard bull plug. The bull plugs were fitted with copper tube connections so that pressure could be applied when the capsules were made up.

The cores were mounted in the capsules by means of wire centralizers whose function was to hold the core in proper position while concrete was poured and set. A special aggregate was prepared using a graded sand and gravel mixture

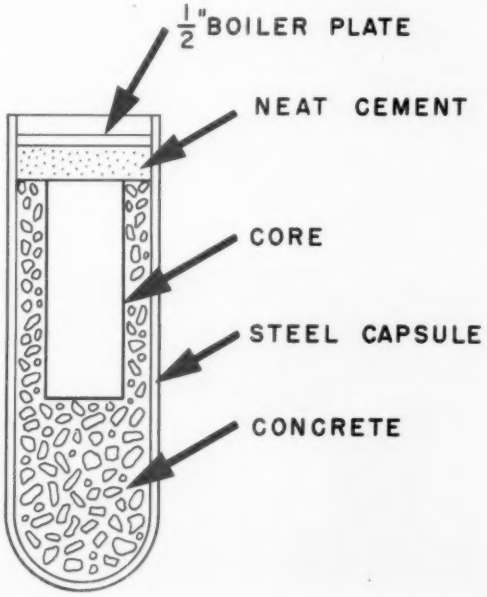

FIG. 1

Manuscript received in the Petroleum Branch office June 28, 1951. Paper presented at the Petroleum Branch Fall Meeting in Oklahoma City, Okla., Oct. 3-5, 1951.

*"Shaped charge" and "jet" are used interchangeably in this report.

**The equipment used for these tests was that offered by the Lane-Wells Co. in early 1949 when the study was made. Equipment has since become available for bullet perforating which is capable of superior penetration to that reported here.

designed to leave a minimum of voids in the slurry. With the capsules held in a vertical position, the concrete was poured and tamped around the wet cores. The capsules were made up and 50 atmospheres of nitrogen pressure applied for three days to reduce any voids to a minimum size. This elaborate mounting procedure was adopted with the purpose of giving the cores an extremely dense, firm mounting, so that they could react to the shots as if they were still integral with the reservoir.

In certain instances, cracks appeared in the concrete during the setting process. This was undesirable because of the importance attached to having mountings of maximum solidity. The extent of the cracks was explored by drilling with a standard seven-eighths in. core bit. It was found that the cracks were shallow and superficial. All the cracked areas were drilled out, and the resulting holes were packed with neat cement.

Ten samples were mounted vertically, so that the shots would enter them in a direction perpendicular to the bedding plane. Four additional samples were prepared by sawing sections from a core, and mounting them side by side sandwich-wise so that the shots would enter in a direction parallel to the bedding plane. Each sample was covered with a layer of neat cement 1.4 in. thick. All the samples, except four of the vertically mounted ones, had a disc of one-half in. thick boiler plate placed against the wet neat cement layer. The 1.4 in. neat cement, plus the boiler plate were intended to correspond to the cement and casing in a standard completion. The samples with no boiler plate were intended to simulate open-hole completions.

Gun holders were fabricated from eight-in. pipe by notching and fitting with set screws. It was necessary to cut excess metal out of the holder in the part nearest the gun in order to allow a relatively free path for expanding gas. Fig. 2 shows a cut out gun holder in place on a capsule. Fig. 3 shows one not so prepared, and Fig. 4 shows the rupture caused by a single shot.

The gun shown in Fig. 3 was the one used for conventional bullet shots. The muzzle is centered over the core sample. The small pipe extending up is a conduit to prevent wetting the detonating wires. The shaped-charge gun was similar in appearance, but was sealed against water by the use of end plates held in place by shear pins.

The bullet equipment used for these tests was called the "type A" gun, which fired 1⅛ x 15/32-in. bullets propelled by 150 grains of powder. Target distance was one in. The standard 28 g shaped-charge was used with a one-in. target distance in all jet shots except two, which were made with the 21 g jet, and a target distance of 1⅞ in.

A simple wooden crate was prepared to support the sample and gun assembly in a vertical position. The assembly, as in Fig. 3, was submerged in water for firing the shot. Most of the water was blown out of the tank with each shot. Some idea of the difference in intensity of the respective explosions may be obtained by comparing Fig. 5 with Fig. 6. Both photographs were taken at approximately the maximum height of the water column. Fig. 5 shows the effect of a bullet charge, while Fig. 6 is from a shaped-charge.

The tank in which the shooting was done was prepared by welding together two oil drums and cutting off part of one. It was buried with only a small part extending out of the ground, and was tightly packed in place with rocks and earth. The tank was deformed to the extent of splitting before the testing was completed, in spite of the top being open. Fig. 7 shows the extent of stretching. Note that the "V-crimp" lines of the complete drum are almost invisible.

Flow test results are presented in Table I. These were made by drilling into the sample capsules (after firing the shots) perpendicular to sample axis, with a small core drill. The distance from the hole to the top of the core was held constant, and as great as the shortest sample would allow. A small packer was seated in the hole to prevent air flow going directly into the mounting concrete. An air pressure at 50 psig was imposed, and the flow rate of all air coming from the top of the capsule was measured. This number is expressed below as "flow-rate." Additionally, permeabilities were measured on the plugs cut from the concrete and from the formation sample.

OBSERVATIONS

There is a significant difference between bullet and jet perforations in depth of penetration and in extent of fracturing. A comparison of the two in regard to depth of penetration is given in the tabulations (Table I). The column called, "Net Penetration," contains a set of data giving the amount (depth) of open perforation hole in the core left by the shots. The data were obtained by subtracting from the total penetration

FIG. 2

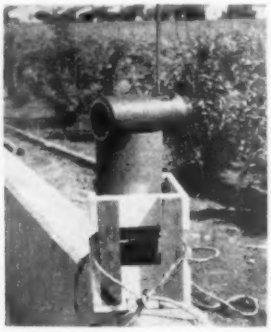

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

the thickness of steel plate and/or neat cement traveled through. Total penetration in bullet holes was measured to the base of the bullets. On this basis of penetration alone, and assuming for the moment no fracturing, compacting, or other side effects, there is a substantial advantage in using jet shots. The average net jet penetration is 3.0 in., while the average for bullets is 0.2 in.

It would be expected that other effects than penetration should be evaluated. These would include fracturing, compaction, etc. The extent of fracturing that occurs in a hard, tight formation is important in its contribution of surface area from which oil may flow. A study of the photographs will show that in every case, bullet or jet shot, there was considerable fracturing. It will be observed that the fractures are more extensive in those samples shot with the shaped-charge. A significant fact that is not evident in the photographs is that a large number of fractures occurred in each case which did not open up enough to be visible. In the vicinity of the shot and throughout the zone of penetration of the core, the rock can be broken up into gravel sized pieces with the hands. This is true of every sample, bullet or jet, and the effect seems to extend some distance radially from the shot-path.

A study of Table 1 shows that there is no correlation from these experiments between flow results and type of perforation. While the samples were selected for their uniformity, it would hardly be expected that they should be sufficiently uniform to allow tests to vary directly with penetration. A slight shale break through a core would upset the flow tests, as would any other variation in permeability. Probably a greater cause of error in the flow data is the fact that the cores were not isolated from the concrete mounting material. It is possible that air, entering the core under pressure, traveled immediately to the cement, and thence out at the low pressure end, giving essentially a measure of the cement permeability.

In the immediate vicinity of the jet shots, and extending into the formation a distance of one-eighth in. to one-fourth in. the

Table 1 — Summary
Shot Record with Resultant Measurements

Sample No.	Core Orientation	Cover[1]	Type Shot	Depth of Penetration,[2] in.	Net Penetration,[3] in.	Air Permeability, md		Flow Rate[4] cu cm/min
						Core Plug	Cement Plug	
1	Vertical	None	Jet	5-3/4	4.4	1.2	0.10	333
3	Vertical	None	Jet	4-1/2	3.1	0.25	0.07	105
4	Vertical	None	Bullet	1-5/8	.2	.....	0.08	.....
5	Vertical	Plate	Jet	4-5/8	2.7	0.60	.....	312
6	Vertical	None	Bullet	2-1/4	.8	0.05	0.25	109
10	Vertical	Plate	Bullet	1-7/8	–.3	0.05	0.02	.....
12	Vertical	Plate	Small Jet	1-3/8	.5	3.0	0.30	250
16	Vertical	Plate	Small Jet	3-3/16	1.2	0.17	0.50	38
18	Vertical	Plate	Bullet	1-7–8	.0	1.3	0.07	172
20	Vertical	Plate	Jet	6-1/4	4.4	1.0	.....	.....
A	Horizontal	Plate	Bullet	2-5/8	.7	1.58	0.22	.....
B	Horizontal	Plate	Jet	5-5–16	3.4	0.10	0.20	10
C	Horizontal	Plate	Jet	5-1/8	4.2	5.04	0.32	136
D	Horizontal	Plate	Bullet	1-5/8	.0	0.43	0.29	.....

[1]No cover simulated open-hole; cover plate simulated casing.
[2]Open hole to base of bullet and to bottom of jet shot.
[3]Length of open perforation hole in core.
[4]cu cm/min at 50 psig differential.

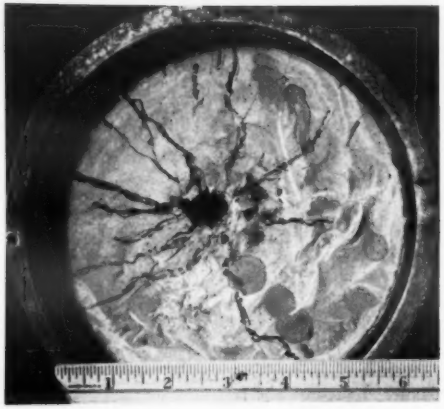

FIG. 8 — BULLET SHOT NO. 6 WITH NO COVER PLATE. FRACTURE LINES IN NEAT CEMENT WERE DARKENED.

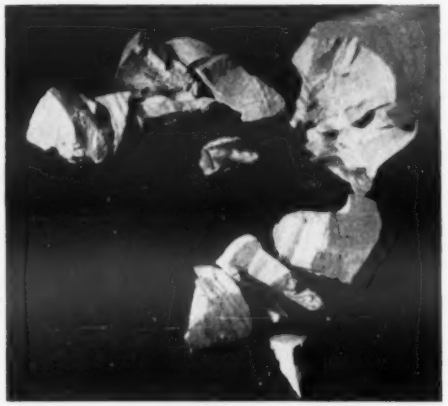

FIG. 9 — BULLET SHOT SAMPLE NO. 6 AFTER REMOVING MOUNT. LARGE PIECES FRACTURED OFF EXTENDING ABOUT 2 IN. AHEAD OF BULLET NOSE.

FIG. 10 — BULLET SHOT NO. 10 WITH COVER PLATE. NOTE BURR AROUND BULLET HOLE.

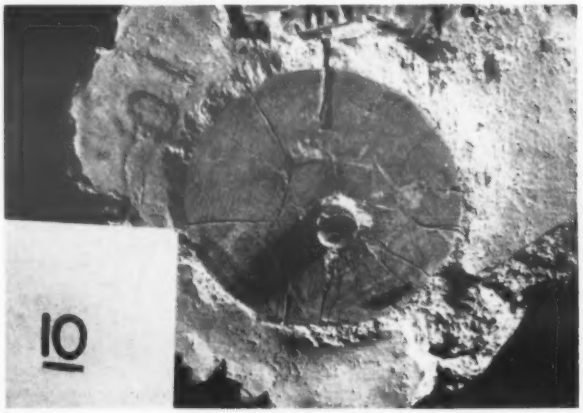

FIG. 11 — BULLET SAMPLE NO. 10 AFTER REMOVING COVER PLATE AND NEAT CEMENT. BULLET DID NOT COMPLETELY ENTER CORE. NOTE ABSENCE OF FRACTURES IN CONCRETE MOUNT.

FIG. 12 — BULLET SAMPLE *D*, MOUNTED FOR HORIZONTAL PENETRATION. FRACTURE PENETRATED ONLY FIRST LAYER.

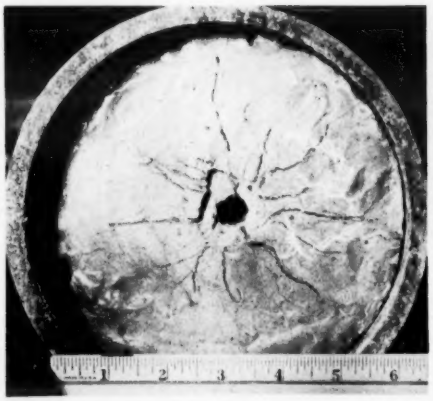

FIG. 13 — JET SAMPLE NO. 3 WITH NO COVER PLATE. FRACTURE LINES WERE DARKENED AS IN FIG. 8.

FIG. 14 — JET SAMPLE NO. 3 AFTER REMOVAL OF NEAT CEMENT AND CAPSULE. COMPARE FRACTURING WITH BULLET SHOT, FIG. 11.

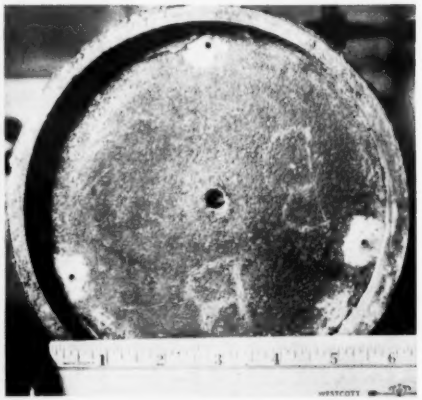

FIG. 15 — JET SAMPLE WITH COVER PLATE. NOTE ABSENCE OF BURR. VISIBLE PARTICLE IN HOLE IS BRASS "CARROT."

FIG. 16 — JET SAMPLE NO. 5. COVER PLATE WAS BLOWN OFF BY EXPLOSION. NOTE DIFFERENCE IN DIAMETER OF ENTERING HOLE IN PLATE AND IN NEAT CEMENT. ALSO, NOTE FRACTURES ARE MINOR IN NEAT CEMENT.

FIG. 17 — JET SAMPLE NO. 5 AFTER REMOVAL OF MOUNTING MATERIAL. PENETRATION OF ONLY 4⅝ IN., BUT WITH SEVERE FRACTURING AND WITH CRACKS AHEAD OF PENETRATION 4 TO 5 IN.

FIG. 18 — SMALL JET SAMPLE WITH COVER PLATE. COMPARE HOLE SIZE WITH FIGS. 15 AND 16.

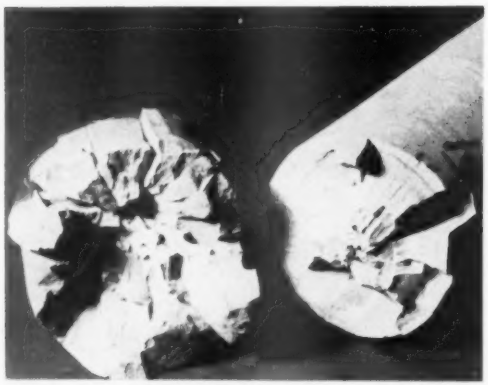

FIG. 19 — SMALL JET SAMPLE AFTER REMOVAL OF MOUNTING MATERIAL. FRACTURED PIECES HELD TOGETHER WITH TAPE TO ILLUSTRATE GEOMETRY OF FRACTURE.

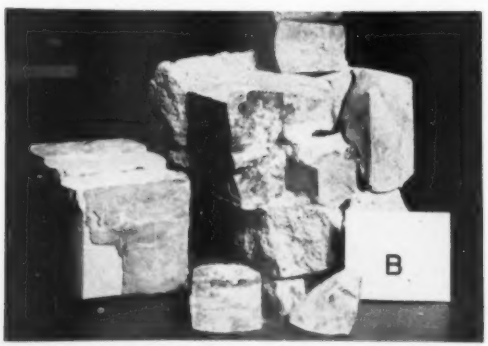

FIG. 20 — JET SHOT FIRED INTO HORIZONTALLY MOUNTED SAMPLE. PENETRATION AND FRACTURING IN THREE LAYERS, BUT FRACTURING NOT SO SEVERE AS IN VERTICALLY MOUNTED SAMPLES.

rock is practically powdered. It is believed that this effect, rather than restricting flow, will possibly assist by opening up a larger effective hole than the actual diameter of the perforation.

INDIVIDUAL SAMPLES

Table I provides a summary of the conditions under which each test shot was fired. Figs. 8 through 20 are photographs of representative samples at various stages of the study. Included are examples of each type perforation on each type target, and of fracturing caused by each. The captions are intended to be self-explanatory.

CONCLUSIONS

1. Insofar as the application of perforation methods to hard, dense limestone formations is concerned, the shaped-charge shows superiority over the conventional bullet both in depth of penetration and in extent of fracturing.
2. The formation sustained no apparent damage from perforating with shaped-charges due to fusion, compaction or similar effects that might interfere with the flow of fluids.
3. On simulated open hole completions, the neat cement layer seemed to be fractured as badly by one method as the other.
4. Based on limited data, it seems that when perforating through casing the shaped-charge causes less fracturing of the neat cement layer than does the bullet.
5. The extent of "preceding" cracks, coning ahead of the perforation, is thought to be significant, and is superior for the shaped-charge.
6. The data obtained from these experiments should not be used indiscriminately on formations of different characteristics from the one studied. Evaluation of perforation methods on different type formations can either come from additional laboratory work, from field experience, or both.

ACKNOWLEDGMENT

The writer wishes to express his appreciation to the Lane-Wells Co. for providing the special equipment and personnel necessary to make these tests. Appreciation is also expressed for the able assistance offered by P. B. Morris of The Atlantic Refining Co.

DISCUSSION

By George C. Howard, Stanolind Oil and Gas Co., Tulsa, Okla., Member AIME

The problem of accurately evaluating the performance of bullet and jet perforators under simulated well conditions is very difficult, particularly if the results are to be extrapolated or applied to field use. Lewelling has presented a suggested method of accomplishing this objective that should furnish a fairly accurate indication of the relative ability of bullet and jet perforators to penetrate the cores tested. There is some question, however, on whether or not the extent of fracturing, indicated in Lewelling's work, is representative of what actually takes place in a well. Similar tests conducted to evaluate this point have shown a wide variation in the amount of fracturing caused by both bullets and jets when fired in massive sandstone outcrops when compared to similar shots fired in substantially backed sandstone cores. ★ ★ ★

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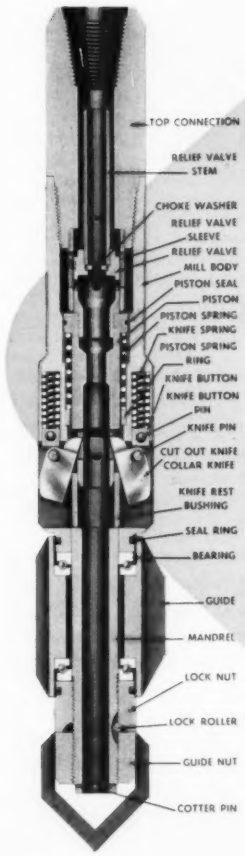

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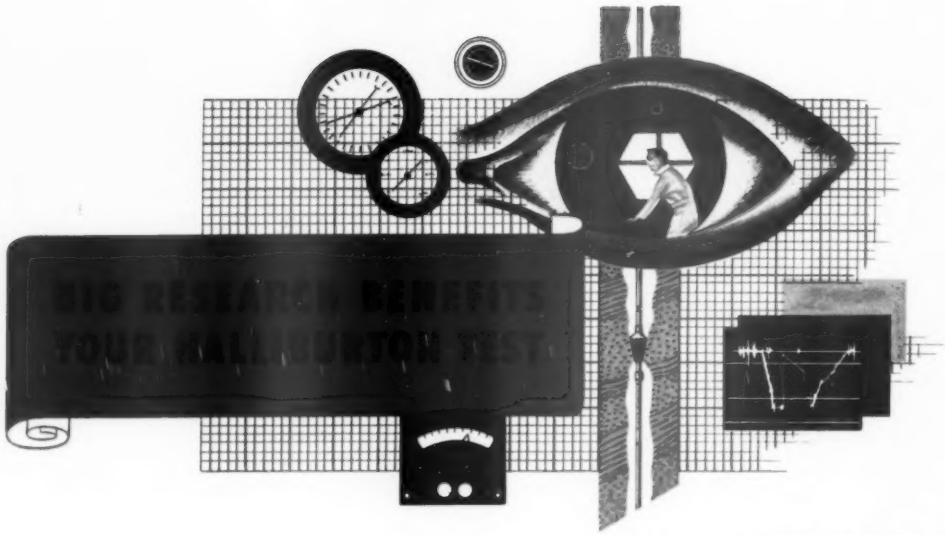

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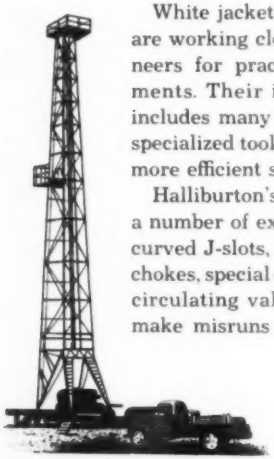

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We understand that a certain number of AIME members read this department to the exclusion of all else in the journals. We even have fairly definite proof that this statement applies to 0.05 per cent of the members. For the benefit of this possibly small but undoubtedly select group, we want to call attention to the statement about the dues referendum that appears on the editorial page of this issue.

Now of course this Institute, which has been running along through good times and bad for 81 years, will not go out of existence if the Member dues go back to $15 and the Junior dues to $10. But it seems fairly certain that the Directors will not, in fact cannot, take a chance on a deficit next year, so in one way or another you would get less than you get now. So it boils down to what you want. A $20 or a $15 Institute, or even a $10 Institute would be possible if AIME members were willing to forego most of the things that have made the AIME what it is.

On the other hand, it is entirely possible that if we should do as the ASME recently did, and raise our dues to $25, or as the Engineers Society of Western Pennsylvania did and raise them to $30, we could give our members so much more that they would think the increase a good investment. We do not think it would ever be advisable, though, to raise our initiation fees and dues to the levels of some of the labor unions!

Ian Campbell wonders if we have called attention to the fact that the present $20 dues are really no more than the old $15 dues because they can be deducted from income for tax purposes and most of our members are in the 25 to 30 per cent tax category. We explained this in some detail in the Drift for March, 1949. But as some of our younger members have pointed out, the argument falls down when the taxpayer takes a flat 10 per cent deduction and does not itemize his business expenses and contributions.

Your ballot should reach you before the end of June (it goes only to members in North America) and should be returned right away. Like the politicians, we urge every one to vote. Particularly if they vote right. Three-fifths of the members voted in the last referendum. Let's do better this time.

Modern Company Reports

Never before have the annual company reports in the mineral industry field exhibited the typographical art so abundantly as does the current crop. Time was when most company reports made a drab appearance and dry reading, mostly confined to financial data and text that gave little information to the public or technical men. Now, the dollar statistics assume less importance. Considerable information is given on what is going on at the company's plants, new equipment being installed, new methods, properties under development, reserves and grades, and similar information of interest to professional men working in the field. We have one suggestion for further improvement: The names of the officers and directors of the company are always given, but only a few companies give the names of the principal operating officials. We think, in the case of a mine for example, that the name of the general manager, his assistant, the mine and mill superintendents, and any other top operating officials who have been largely responsible for the success of operations, are worthy of mention. The reports are now widely read and this recognition is due them.

Comment on economics, taxes, and labor give an excellent picture of what our industry is facing. Consider the following, from the report of the Union Oil Co. of California:

"Your company, as well as industry generally, is finding it extremely difficult to maintain the financial resources necessary to cover the high cost of replacing raw material reserves and facilities and at the same time expand its operations. Not only are taxes severely limiting the accumulation of capital by industry, but they are reducing the savings of individuals, the basic source of risk capital, and eliminating the incentives for investment. Simultaneously industry is prevented by price control from recovering most increases in cost brought about by inflationary wage increases and taxes.

"As a result of the inflation induced by unbridled Government spending, we can no longer regard profit as simply the difference between sales revenues and recorded costs. The reason is that only a portion of recorded costs are expressed in today's dollars. Depletion and depreciation costs which provide for the recovery of capital invested in properties and facilities are limited to the number of dollars initially invested. Because of the decline in the purchasing power of today's dollar, the amounts set aside for depletion and depreciation are simply not enough to meet replacement costs. Therefore, it is a literal fact that a substantial portion of the amount reported as profits is actually not profit, but should be recorded as a return of capital needed to keep the company a going concern. It is not too much to say that this portion of apparent profits on which your company is taxed, represents an involuntary liquidation of capital assets. There is a serious doubt whether your company's reported profit figures, in common with most of industry, have any real meaning. . . .

"It is seldom recognized that the purchasing power of industry's dollar has declined even more than has that of the individual. During the past 10 years, the wholesale price index, a measure of industry's cost of doing business, has increased 107 per cent while the consumers price index has increased 76 per cent."

Birthday Greetings

AIME's oldest living member was born on July 3, 1849, so next month will be 103 years old. He is Dr. Edward A. Uehling, of 2360 South 81st St., West Allis 14, Wis. We have a letter from him dated March 21 which says, "The years and weather keep me confined to my room. I extend hearty greetings to all the members of the Institute." We think it would be nice if some of our members responded to this greeting. Dr. Uehling joined the Institute 66 years ago, nine years after he was graduated from Stevens Institute. His work was in iron and steel, and 65 years ago he was superintendent of blast furnaces for the Bethlehem Iron Co., at Bethlehem, Pa. He then became furnace manager for the Sloss Iron and Steel Co. at Birmingham, Ala. Later he developed and introduced a pig iron casting machine and a pyrometer. He was one of 11 children and his mother lived to be 99. ★ ★ ★

Basil P. Kantzer
For Vice-Chairman

Claude R. Hocott
For Chairman

John P. Hammond
For Vice-Chairman

Nominees for Petroleum Branch Offices, 1953

For Chairman

CLAUDE R. HOCOTT is assistant head of the Production Research Division, Humble Oil and Refining Co., in Houston, Tex. He joined Humble in June, 1937, as research engineer, and has held his present position since 1942. A native of Arkansas, Hocott was awarded the BS, MS and PhD degrees in chemical engineering at The University of Texas, where he was a member of Tau Beta Pi, Phi Lambda Upsilon, and Sigma Xi. He is presently active in the American Electrochemical Society and is a member of the API Research Advisory Committee. Hocott and his wife, Edna Rae, have two daughters, Gail, 9, and Elaine, 12. He is an elder in the Church of Christ and spends his leisure hours at his hobbies of photography, fishing, hunting, flowers and music.

For Vice-Chairman

BASIL P. KANTZER is now manager of natural gas and gasoline for Union Oil Co. of California, having joined the company's field staff after graduation from Stanford University in 1934. Through a series of promotions he became foreman of production, chief production engineer, and manager of California field operations, before achieving his present position last year. Chairman of the Southern California Section of AIME for 1952, he has also been Chairman of the Pacific Petroleum Chapter (1951). He is serving his fourth term on the council of the Chapter, and his second year as a Section Director. He has also been chairman of the Engineering Board of the Conservation Committee, California Oil Producers; chairman of the Pacific Coast District and member of the General Committee, Division of Production, of the API; and chairman of the Paloma Unit Engineering Committee.

For Vice-Chairman

JOHN P. HAMMOND, a native of Okmulgee, Okla., received his petroleum engineering degree from the University of Tulsa. Now assistant general superintendent of production for the Amerada Petroleum Corp., he has been in the Tulsa office of the firm since 1943. He was employed by the Royal Petroleum Corp. in Tulsa and the Mid-Union Drilling Co. in North Texas and the Texas Panhandle before joining Amerada as a petroleum engineer in Louisiana in 1941. He served the AIME as Chairman of the Mid-Continent Section in 1948-49, and is Chairman of the Publications Committee for 1952.

For Executive Committee

THOMAS A. ATKINSON, assistant manager of Rocky Mountain operations for General Petroleum Corp., first worked for the company as a high school student in 1926. After receiving his mechanical engineering degree from the University of California in 1933, he joined the company's engineering staff, becoming assistant to the superintendent of the southern division, production department, in 1944. He was manager of the industrial relations department from 1948 to 1951, when he assumed his present position. He has served as program chairman for the AIME Fall Meeting, Chairman of the Southern California Section and Chairman of the Pacific Junior Group. Atkinson has four children, and his hobbies include overnight hiking and skiing.

For Executive Committee

ROLAND GOULDY, pool engineer for Hull-Silk Repressuring Association located in Wichita Falls, Tex., was until May of this year a petroleum engineer for Bridwell Oil Co. He is a 1939 graduate of the petroleum engineering school at the University of Texas, where he was Chairman of the Student Chapter of AIME. He has since served as Chairman, Vice-chairman and Director of the North Texas Section. He is co-author of "Gas Repressuring in Texas," a chapter in *Secondary Recovery of Oil in the United States, 2nd ed.*, API; and of "Some Examples of Successful Gas Repressuring in North Texas," *Producers Monthly*.

★ ★ ★

The Branch Nominating Committee, composed of R. W. French, chairman, H. F. Beardmore, J. C. Calhoun, Jr., H. S. Kelly and M. B. Standing, has nominated the members pictured on this page for positions in the Branch government. Article IX of the By-Laws calls for publication in June of the pictures and biographies of these nominees. Any group of 10 members may submit additional nominations until August 15. A letter ballot, covering all positions to which the membership has submitted nominations, will be mailed in September. If there are no nominations from the membership by August 15, the letter ballot will be dispensed with and the Committee's nominees will be declared automatically elected. The new officers will be installed at the 1953 Annual Meeting in February.

Thomas A. Atkinson
For Executive Committee

Roland P. Gouldy
For Executive Committee

Proposed for Membership, Petroleum Branch

Total AIME membership on March 31, 1952, was 17,512; in addition, 2,260 Student Associates were enrolled.

ADMISSIONS COMMITTEE

T. D. Janes, chairman; Thomas G. Moore, vice-chairman; H. S. Bell, F. W. Hanson, R. H. Chadwick, T. W. Nelson, C. A. R. Lambly, John T. Sherman, A. C. Brinker, G. P. Lutjen, Ivan Given, E. A. Prentis, C. Leslie Rice and J. H. Scaff.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend privileges, but does not desire to admit persons unless they are qualified. Objections on applications should be received on the 15th of the month following publication of PETROLEUM TECHNOLOGY.

In the following list C/S means change of status; R, reinstatement; M, member; J, Junior Member; A, Associate Member; S, Student Associate; F, Junior Foreign Affiliate.

CALIFORNIA

Bakersfield — Mathison, Hendrix B. (C/S-S-J); Monson, Charles E. (J); Woidneck, Robert F. (R,C/S-S-J).
Hawthorne — Sauer, William D. (C/S-S-J).
Long Beach — Anderson, William (A); Johnson, David R. (R,C/S-S-J).
San Francisco — Murdock, Roy K. (R,C/S-S-J).

INDIANA

Evansville — Gallagher, Victor R. (M).

LOUISIANA

Lafayette — Everett, Robert H. (R,C/S-S-M).
New Orleans — Fitzpatrick, Harvey J. (J).

MASSACHUSETTS

Westover AFB — Carroll, Fred M. (C/S-S-J).

NEW YORK

Larchmont — Blue, Sidney D. (A).
New York — Randall, Duane C. (R,C/S-J-M).

OKLAHOMA

Bartlesville — Bohon, William R. (R,C/S-S-J).
Ponca City — Brown, Chester L. (C/S-A-M).
Tulsa — Carpenter, Forrest L. (M); Gove, Norman B. (J).

PENNSYLVANIA

Kingston — Wright, Lundy R., Jr. (J).
Washington — Ebitz, Frank M. (R,C/S-S-J).

TEXAS

Beeville — Red, J. B. (J).
Corpus Christi — Moore, Clarence E. (J); Page, Murry D. (J); Scott, Howard W. (J); Spears, Gordon S. (J).
Dallas — Hutchinson, Thomas S. (J).
Encino — Hester, Carl T. (J).
Fort Worth — Cone, Truett M. (M); Robinson, Reginald L. (C/S-A-M); Vann, John R. (M).
Houston — Chriss, Merle D. (M); Norris, Norman Edgar (J); Rebold, John H. (J).
Levelland — McGaugh, Thurman E., Jr. (J).
Lubbock — Bowersock, Dale D. (M).
Midland — Hassell, Thomas W. (J); Lindsey, Hiram E., Jr. (J); Muerer, Marcus C. (A).
Seagraves — Simmons, Charles M. (J).

WYOMING

Casper — Grove, Richard E. (J); Kahls, William R. (J).

FRANCE

Paris — Mediasko, Delorme Gerard (M).

INDONESIA

Sumatra — Davenport, Robert E. (M).

★ ★ ★

Henry Heald Receives Washington Award

Henry Townley Heald has received the Washington Award "for distinguished leadership in engineering education, industrial technology, scientific research, and civic affairs." The AIME and the other three Founder Societies, together with the Western Society of Engineers, recommend recipients for the award through representatives on the Washington Award Commission. The Western Society of Engineers administers the award, which is an honor conferred upon an engineer for accomplishments which pre-eminently promote the happiness, comfort, and well-being of humanity.

Heald was recently made Chancellor of New York University. Previous to that he was president of the Illinois Institute of Technology for 11 years and before that, at the age of 34, was made president of Armour Institute of Technology. He has served in one or more capacities in over 50 civic, social, religious, technical, and governmental groups.

AIME members who have received the Award in the past have included Herbert Hoover, Robert Woolston Hunt, Ambrose Swasey, F. G. Cottrell, D. C. Jackling, and Wilfred Sykes. ★ ★ ★

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FIELD ENGINEERING OFFICES IN 26 PRINCIPAL CITIES

Personals

JOE A. LAIRD has resigned as assistant professor of petroleum engineering at Texas A&M College to become a candidate for Texas Railroad Commissioner. Laird holds the BS degree in petroleum engineering from Texas A&M, and the MS in geology from the University of Oklahoma. After a year's work in secondary recovery operations in Wichita Falls, Tex., he was in the Houston district office of the Oil and Gas Division of the Railroad Commission for 2½ years. For five years preceding his teaching appointment, he did engineering and geological work in Houston, the last two years as an independent consultant. Laird is a member of AAPG and the Houston Geological Society, as well as of AIME.

+

EUGENE L. MAXWELL is now with the Lion Oil Co., Midland, Texas.

+

DONALD F. HARRIS has become engineer with the Gulf Oil Corp., Pittsburgh, Pa.

+

ALFRED D. BROWN has joined the Gulf Oil Corp. as an engineering trainee in the West Texas district.

+

GEORGE W. UNDERWOOD is now associated with the Mexican American Independent Co., Mexico, D. F.

+

JOHN F. PATERSON, production superintendent, Husky Oil & Refining Co., Ltd., is now located at Lloydminster, Sask., Canada. He had been at Cody, Wyo.

+

S. ANTHONY STANIN is with the Standard-Vacuum Oil Co., Calcutta, India.

+

ROBERT B. CHAPMAN is now assistant division engineer, central div., Carter Oil Co., Oklahoma City.

+

WILLIAM A. KOEDERITZ has joined the Magnolia Petroleum Co., Midland, Texas.

+

RICHARD LEWIS PARSON has been promoted to administrative assistant to the manager, La Habra laboratory, California Research Corp.

E. J. HAMNER has been appointed manager of operations in California for Humble Oil and Refining Co. Hamner has been with the company since his graduation from the University of Oklahoma in 1932, working in the production and exploration departments in Texas. He became assistant chief geologist in Houston in 1946, and was named manager of exploration in California in 1948.

+

JOHN S. BELL is now assistant manager for California of the Humble Oil and Refining Co. A native of Fort Worth, Tex., Bell was graduated from the University of Oklahoma in 1930. He joined Humble in 1933, serving as district petroleum engineer for Southwest Texas and later as division engineer in North and East Texas. In 1951 he became district superintendent in California. Bell is active in the API and the AAPG, as well as serving currently on the executive committee of the Petroleum Branch, AIME.

+

WILLIAM F. KRUEGER, for the past five years in charge of sales in the Houston district of Sperry-Sun Well Surveying Co., has been promoted to general sales manager, with headquarters at Houston. A graduate in petroleum engineering from the University of Oklahoma, Krueger was with the U. S. Bureau of Mines for about three years before joining Sperry-Sun in 1938 as a sales and service engineer.

+

LOWELL M. WILHOIT has been appointed production manager of Otis Engineering Corp., manufacturing affiliate of Otis Pressure Control. Wilhoit was general sales manager for the company prior to his assignment to the engineering post.

+

RICHARD C. BANISTER recently has been transferred to the Texas central division office, Standard Oil Co. of Texas, San Angelo.

+

FOSTER MORRELL has resigned after 25 years with the U. S. Geological Survey. He has opened his office in Roswell, N. Mex., as a petroleum consultant.

THOMAS C. HIESTAND has opened offices in the Continental Building Denver, Colo., to direct oil and gas operations in the Rocky Mountain Region for a unit composed of F. Kirk Johnson and Brooks Scanlon, Inc. Heistand was previously regional staff geologist for Cities Service Oil Co. A graduate of Indiana University in geology, Heistand is currently serving as secretary-treasurer of the Rocky Mountain Section of AAPG.

+

WILLIAM A. MORRISON has accepted a position with the Phillips Petroleum Co. as engineer-trainee in the drilling dept.

+

ROBERT R. DELUCA is now with the Robert H. Ray Co., Refugio, Texas.

+

JOHN O. NIGRA is now with the Arabian American Oil Co., New York.

+

A. JOHN HAWORTH has become petroleum geologist with the American Overseas Petroleum, Ltd., New York.

+

GLENN W. KING, Stanolind Oil and Gas Co., Levelland, Texas, is now located at Tulsa.

+

WILLIAM DAVID SMITH, JR., has been transferred to Houston by the Union Sulphur & Oil Corp. He had been in Sulphur, La.

+

GEORGE L. THOMAS is now with the Geophysical Service, Inc., Dallas.

+

WILLIAM K. WHITEFORD, formerly with the British American Oil Co., has joined the Gulf Oil Corp., Pittsburgh, as executive vice-president.

+

C. J. KOSAREK, JR., has accepted a position with the Freeport Sulphur Co., Point Sulphur, La.

+

LOUIS O. HEINTZ has joined the St. Anthony Oil Corp., Santa Fe Springs, Calif.

+

William R. Dunn, Bishop Oil Co., was recently transferred to Midland, Texas, from San Francisco.

Redwater Field

Continued from Page 21, Section 1

be recovered. Three different possibilities are being considered: (1) Inject enough water to restore the original pressure and return most of the wells which are now pumping to a flowing status. (2) Maintain the pressure slightly above the bubble point. (3) Maintain the pressure slightly below the bubble point in an effort to build up a free gas phase and increase the ultimate oil recovery. ★ ★ ★

Petroleum Education

Continued from Page 19, Section 1

of production. In order to maintain the student's interest he should be given some chance to view the practical side of the industry by a few field trips during his last two years in college. A trip to a drilling rig or a refinery would stimulate his interest for a time. The practical experience will indeed come after graduation, but most students would like to know more about industry before that time.

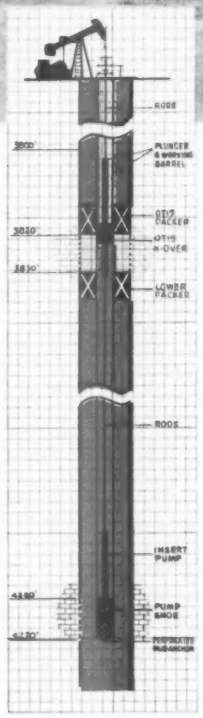
Fortunately, some students have worked in the field and have the benefit of that practical experience. Johnson has found that the few years he spent on a rotary drilling crew made the concepts of petroleum engineering easier for him to follow. At the same time, it is easy to see why a company employing a petroleum engineer would prefer that he be well schooled in the basic fundamentals and be willing to teach him the practical aspects during the training program.

Dale Johnson would also like for the petroleum engineering course to include more general subjects, specifically, such courses as personnel management and public speaking.

The fact remains that there are only four years in the normal engineering course at the present time and the number of units of work required already approaches that of a five-year course. Johnson believes that eventually it will require five years to graduate as an engineer. Meanwhile, it might be a good idea to re-examine the non-engineering subjects now required and possibly make some substitutions.

With field trips to maintain the student interest at a high level, proper selection of non-engineering courses, a good background in the basic fundamentals of petroleum engineering, and the ability to express himself, both verbally and in writing, Johnson believes that the engineer upon graduation will be better qualified to take his place in society and in industry. ★ ★ ★

Otis Two-Zone Sub-Surface Pump for Dual Completions



If you are operating in a field with several good horizons, you will want to investigate this Otis equipment for pumping two formations through a single well bore. The Otis Two-Zone Pump is an assembly of two sub-surface pumps which stroke simultaneously on a single rod string. There are no complex fittings or complicated sub-surface installations, nor is any extra surface equipment required, other than an additional flow line at the wellhead. The lower zone is pumped in the tubing and crossed over into the annulus by means of a special Otis Cross-Over Packer which also serves to separate the two zones; at the same time, another pump produces the upper zone through the casing and into the tubing to surface *(see diagram)*. Actually, both formations are pumped in the conventional manner and at no time do the fluids commingle. Otis Two-Zone Pumps are in successful operation in multiple-pay fields throughout the Mid-Continent area. If you have production in such a field, ask your nearest Otis office to show you how you can pump a *second* oil well profitably and economically, and with a surprisingly small outlay for extra equipment. Or if you prefer, we'll be glad to send you illustrated bulletins containing complete details on this and other Otis equipment for producing both pumping and flowing multiple-zone wells. Contact Otis Pressure Control, Inc., 6612 Denton Dr., Box 7206, Dallas, or the Otis office in **Houston, Corpus Christi, Victoria, Falfurrias, Longview, New Iberia, Houma, Shreveport, Oklahoma City, or Elk City.**

PRESSURE CONTROL OTIS SERVICE EQUIPMENT

Otis Two-Zone Pump

OTIS PRESSURE CONTROL, INC.

Employment Notices

The JOURNAL will post notices of men and jobs available. Companies and AIME members are invited to use this space, for which there is no charge. Except as noted below, address replies to: Code (appropriate number), JOURNAL OF PETROLEUM TECHNOLOGY, 408 Trinity Universal Bldg., Dallas 1. Show return address on envelope. These replies will be forwarded unopened and no fees are involved.

Replies to the positions coded Y5908, Y5858, Y5532, Y6427, Y5531 below should be addressed to: Engineering Societies Personnel Service, 8 West 40th St., New York 18, N. Y. The ESPS, on whose behalf these notices are published here, collects a fee from applicants actually placed.

PERSONNEL

♦ Petroleum engineer, 29, desires responsible engineering and/or supervisory position with progressive organization in Rocky Mountain or Mid-Continent area. Three years' petroleum engineering experience in drilling and production with major company in Rocky Mountain area. Have competent knowledge of principles of reservoir engineering and electric and radioactivity log analysis. Also equivalent of three years' roustabouting and roughnecking experience prior to graduation. Code 164.

POSITIONS

♦ The Continental Oil Co. has openings for several reservoir engineers at Ponca City, Okla. Work will consist of calculating and maintaining records of company reserves, evaluations, secondary recovery applications, and reservoir studies. Prefer men 23-35 with some experience. Excellent working and recreational facilities. Salary commensurate with education and experience. Write direct to J. A. Murphy, Chief Reservoir Engineer, P. O. Box 1267, Ponca City, Okla.

♦ Reservoir engineer, minimum five years' experience, some field training and production experience desirable. Location, California. Code 541.

♦ Engineers. (a) Oil refinery process design engineer, 30-40, chemical or mechanical engineering graduate, with actual oil refinery distillation process design work on cracking plants or equivalent. Will supervise engineers and draftsmen in the design of all types of distillation units from flow plans and data. Must be able to discuss with oil refinery expert, all phases of oil refinery design. Salary open. (b) Oil refinery field maintenance and construction superintendent, 30-60, with actual experience in the field working for an oil company or for a contractor who has contract work in an oil refinery performing the work listed as follows: Hiring and supervising all classes of mechanics and assigning them to oil refinery maintenance or construction as required. Salary open. Locations, New York metropolitan area or Gulf Coast area, or both. Y5908.

♦ Project engineer with knowledge of design, layout, mechanisms and material specifications for lube oil furfural solvent extraction, MEK solvent dewaxing and propane de-asphalting units. Should have ability to follow the detailed design, layout and drawings through the engineering department. Salary commensurate with experience, including profit-sharing bonus. Location, Ohio. Y5858.

♦ Engineers. (a) Petroleum engineer for field operations, 25-35, with degree in petroleum engineering or equivalent and about three to five years' experience. (c) Division safety supervisor, 30-45, graduate, preferably mechanical, with five years' experience in petroleum, drilling and production safety supervision. (d) Junior engineers, recent petroleum engineering graduates, capable of developing under training. Location, Peru, S. A. Y5532.

♦ Combustion engineer with BS in mechanical, chemical, petroleum or combustion engineering. Preferably MS in combustion engineering, and not less than 8 and preferably 10 years in combusion engineering field. Experience should cover theory of combustion, liquid fuels and design and maintenance of domestic and industrial burners. Must be able to supervise and direct the activities of a group along a given line in his field, and should be able to train personnel in matters concerning his field. Salary open. Location, Brooklyn, N. Y. Y6427.

♦ Reservoir engineer, 25-40, for petroleum industry, with about five years' reservoir engineering experience. Location, Colombia, S. A. Y5531. ★ ★ ★

PETROLEUM ENGINEER

For New York office of major foreign producer. Four or more years' experience in drilling, development, and production. To supervise section handling equipment procurement and oilfield development engineering. Position encompasses advising management on oil field development planning, and keeping field colleagues abreast of State-side improvements in methods and equipment. Salary commensurate with qualifications.

Write giving personal history and work experience. Please include telephone number.

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Journal of Petroleum Technology
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Dallas 1, Texas

Committee Reports On Hocott Proposal

At the April meeting of the AIME Board of Directors, E. E. Schumacher presented a report of the committee named to study the Hocott proposal. Main points in this proposal are that Local Sections be responsible to, and under the direction of, the Branch Councils rather than be administered by AIME headquarters; and that no more appropriations be made to Local Sections out of the AIME treasury — they would be financed by local dues and assessments. Four recommendations to the Board were made by the Schumacher committee: (1) There shall be no rebate of members' due to Local Sections except as specified by individual members. (2) That the present Institute structure be continued. (3) That the authority of the Branches to serve the professional and administrative needs of local units be confirmed consistent with general Institute policy. (4) That a permanent Inter-Branch Council be established to study Institute organizational problems. This council shall consist of (a) the Institute Secretary, as permanent chairman; (b) the three Branch Chairmen and immediate past Chairmen or their designated alternates; and (c) the three Branch Secretaries. This Council is to meet prior to the meeting of the Board of Directors at each Annual Meeting of the Institute and at any other necessary times.

The Board, at its April meeting, voted to accept recommendations 2, 3, and 4, and to refer recommendation No. 1 to the committee authorized in recommendation No. 4 for future consideration. ★ ★ ★

Branch Council Chairmen Now AIME Directors

By vote of the Board at its April meeting, the bylaws were changed to make Branch Council Chairmen ex-officio Directors of the Institute. Division Chairmen have for some years been ex-officio Directors. Thus the total number of AIME Directors is now 39, consisting of 27 elected Directors, 10 Divisional Chairmen ex-officio, and two Branch Chairmen ex officio. (The Petroleum Division Chairman is the same person as the Petroleum Branch Council Chairman.) ★ ★ ★

Officer Directory

As Section 2 of this issue, is a directory of officers and committee members and AIME representatives on other committees. A complete AIME directory, similar to that issued in 1948 with the addition of the Divisional enrollment of each member, will be issued later, probably in December. Members who have not returned the cards mailed to them for Directory listing should do so imediately. ★ ★ ★

VANCE

SPICE

Vance and Spice Named to Library Posts

Harold Vance, head of the petroleum engineering department of Texas A&M College, has been elected chairman of the board of the Texas Natural Resources Foundation Library. New vice-chairman is William H. Spice, Jr., consulting geologist in San Antonio, Tex.

Located at 328 Aztec Building, San Antonio, the Library is operated by the Foundation as a free source of technical references, with the purpose of rendering aid in the conservation and development of the natural resources of the state. It contains 2,000 bound volumes on agriculture, chemistry, geology, physics, and the engineering fields. The library also maintains bound volumes of technical and professional magazines, including the AAPG *Bulletin*, *Journal of Geology*, AIME *Petroleum Transactions* and *Engineering Index*. ★ ★ ★

$7,000 Surplus Indicated In Approved Budget

The final budget for 1952 was approved by the Board at its April 16 meeting. Income from initiation fees and dues is put at $326,000 ($306,000 in 1951); from publications $221,000 ($205,000 in 1951); other sources $7,000 ($11,000 in 1951); total $554,000 ($522,000 last year). Expenses for membership services and field activities are budgeted at $107,000 ($81,000 in 1951); publications $311,000 ($294,000 in 1951; and general and administrative headquarters expense $129,000 ($139,000 last year).

Branchwise the budget was divided as follows: Mining income $265,500, expense $244,500; Metals income $163,400, expense $180,300; Petroleum income $125,100, expense $122,200.

An overall surplus for the year of $7,000 is indicated. ★ ★ ★

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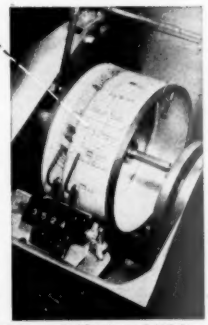

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Permeability of Set Cement

Continued from Page 16, Section 1

cement slurry into the mold. In other cases, the mold was cleansed with emery polishing paper, but no grease was applied to the mold. Permeability tests were first run on the set cement in the mold; the specimen was then removed from the mold with the aid of a hydraulic punch, placed in a rubber holder which was tightly fitted into a steel cylinder, and its permeability to water again determined. Several set cement plugs were dried at 105°C for 24 hours; then their permeability to air was measured.

Substantially the same values for water permeability were obtained with the cement specimen in the ungreased mold as were obtained with the cement specimen placed in the rubber holder. These results indicated that the permeability values obtained by casting cement specimens in ungreased molds were reproducible, that there was no leakage of water around the cement specimen under the conditions used, and that the result represented the true wet permeability of the set cement. Higher and inconsistent values were obtained when the mold was greased. Values obtained for air permeability were much higher than those for water permeability, no doubt due to the alteration of the set cement by drying.

REFERENCES

1. API Code 32: *For Testing Cements Used in Wells* (Tentative), 2nd Edition, (June, 1950). American Petroleum Institute, New York, N. Y.
2. Coleman, J. R., and Corrigan, G. L.: "Fineness and Water-Cement Ratio in Relation to Volume and Permeability of Cement," *Trans.* AIME, (1941) 142, 205.

★ ★ ★

Book Reviews

The following books are available in the Engineering Societies Library, and may be borrowed by mail by AIME members for a small handling charge. The library also prepares bibliographies and translations, and provides search, photostat and microfilm services. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Light Hydrocarbon Analysis

Edited by O. W. Burke, Jr., C. E. Starr, Jr. and F. D. Tuemmler. Reinhold Publishing Corp., New York, 1951. 639 pp., illus., diagrs., charts, tables. 10¼ x 7¼ in., cloth, $15.00.

This treatise is a compilation of data obtained by the Butadiene Committee on Specifications and Methods of Analyses. Supported by extensive tables and other statistical data, the work covers background on processes, detailed analytical methods, accuracy and precision of the methods and safe practices in the laboratory handling of light hydrocarbons.

Corrosion Guide

By E. Rabald. Elsevier Publishing Co., New York, Amsterdam, London, Brussels, 1951. 629 pp., illus., diagrs., charts, tables, 10 x 6½ in., cloth. $12.50.

The major part of this practical reference work is composed of tables showing the interaction phenomena between more than 40 important construction materials (metallic and non-metallic) and some 250 corrosive agents. The object is to provide the chemist or engineer with readily usable information in the choice of materials for laboratory or industrial processes. Corrosion fundamentals are discussed in an introductory section, and a table of the physical properties of the materials involved is provided. A bibliography lists important books and periodicals.

Advertisers' Index

	Page
A-1 Bit & Tool Co. — *Calvin L. Clausel, Jr., Houston*	Sec. 2—1
Arabian American Oil Co. — *Gunn-Mears Advertising Agency, New York*	Sec. 2—8
Axelson Manufacturing Co. — *Heintz & Co., Los Angeles, Calif.*	*
Baash-Ross Tool Co. — *Dozier-Eastman & Co., Los Angeles, Calif.*	Sec. 1—4
Baroid Sales Division — *Darwin H. Clark Co., Los Angeles*	*
Baker Oil Tools, Inc. — *Theo. M. Martin Co., San Gabriel, Calif.*	*
Barret, William M., Inc. — *Bozell & Jacobs, Shreveport, La.*	Sec. 1—2
Black, Sivalls & Bryson, Inc. — *R. J. Potts-Calkins & Holden Adv., Kansas City, Mo.*	*
B and W Incorporated — *Lester C. Nielson Co., Huntington Park, Calif.*	Sec. 1—5
Clark Bros. Co., Inc. — *Harold Warner Co., Buffalo, N. Y.*	*
Cooper-Bessemer Corp. — *Griswold-Eshleman Co., Cleveland, Ohio*	Sec. 1—6
Core Laboratories, Inc. — *Duvall Williams, Dallas, Tex.*	*
Dale Company — *Lester C. Nielson Co., Huntington Park, Calif.*	*
Dowell Incorporated — *MacManus, John & Adams, Inc., Detroit, Mich.*	Sec. 1—8
Eastman Oil Well Survey Co. — *Ted Workman Advertising, Dallas, Tex.*	*
Farrand Optical Co. — *Firestone Advertising Agency, New York, N. Y.*	*
Garrett Oil Tools, Inc. — *W. L. Culver, Houston, Tex.*	*
Geolograph Co., Inc. — *Lowe Runkle Co., Oklahoma City, Okla.*	Sec. 2—9
Halliburton Oil Well Cementing Co. — *Hill & Christopher, Los Angeles, Calif. Bachrodt, Newell, O'Kane and Gano, Chicago, Ill.*	Sec. 1—1, 13, Sec. 2—2
Hycalog Co. — *Glenn Mason Advertising, Shreveport, La.*	*
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Lufkin Foundry & Machine Co. — *Cudlipp Advertising Agency, Lufkin, Tex.*	Sec. 1—7
Magnet Cove Barium Corp. — *Rives, Dyke and Co., Houston, Texas*	Third Cover
McCullough Tool Co. — *R. P. Casterline Advertising, Los Angeles, Calif.*	*
Lee C. Moore Corp. — *Watts, Payne Advertising, Tulsa, Okla.*	*
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Pelton Water Wheel Co. — *Edward A. Stratman Adv., Huntington Park, Calif.*	*
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Schlumberger Well Surveying Corp. — *Rives, Dyke & Co., Houston, Tex.*	Second Cover
The Second National Bank, Houston, Tex. — *Gano, Bachrodt, Edwards, Inc., Houston, Tex.*	*
Sperry-Sun Well Surveying Co. — *Wallace Davis & Co., Houston*	Sec. 1—10
United Geophysical Co., Inc. — *Dozier-Eastman & Co., Los Angeles, Calif.*	Fourth Cover
Well Surveys, Inc. — *Watts, Payne Advertising, Tulsa, Okla.*	*
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TABLE OF CONTENTS

	PAGE
Officers and Directors AIME	1
Standing Committees AIME	2
Official AIME Representatives	7
Branch Councils	10
Institute of Metals Division	11
Petroleum Division	12
Iron and Steel Division	13
Coal Division	15
Mineral Industry Education Division	17
Industrial Minerals Division	18
Minerals Beneficiation Division	20
Extractive Metallurgy Division	21
Mineral Economics Division	22
Mining, Geology, and Geophysics Division	23
Local Sections	25
Alaska, Arizona	25
Black Hills, Boston, Carlsbad Potash, Central Appalachian, Chicago	26
Cleveland, Colorado	27
Columbia, Connecticut, Delta	28
Detroit, East Texas, El Paso Metals, Florida	29
Gulf Coast, Kansas, Lehigh Valley	30
Mid-Continent, Minnesota, Montana	31
Nevada, New York, North Pacific, North Texas	32
Ohio Valley, Oklahoma City, Oregon, Pennsylvania Anthracite	33
Permian Basin, Philadelphia, Pittsburgh, St. Louis	34
San Francisco, Southeast	35
Southern California, Southwest Texas, Southwestern Alaska, Southwestern New Mexico	36
Tri-State, Upper Peninsula, Utah, Washington, D. C.	37
Wyoming, Mexico, Philippine, Rio de Janeiro (Brazil), Lima (Peru)	38
Student Chapters and Faculty Sponsors	38
Woman's Auxiliary	42

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Washington, D. C.—Paul M. Tyler
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Established November 19, 1947
Regular meetings fourth Monday of each month except June, July, and August

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Robert M. Chapman, Vice-Chairman
Robert E. Shafer, Secretary-Treasurer
Box 1170
Fairbanks, Alaska
Robert M. Chapman, Section Delegate

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Established July 10, 1915

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Superior, Arizona
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Established December 18, 1936

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P. O. Box 380
Lead, So. Dakota
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John W. Mitchell, Alternate

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Established September 20, 1911
Meets First Monday of each month
October to May inclusive

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Peter Kosting, Vice-Chairman
R. Schumann, Secretary-Treasurer
Massachusetts Institute of Technology
Cambridge 39, Mass.
R. Schumann, Section Delegate

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H. Rush Spedden, Student Adviser
A. M. Gaudin, Chairman,
Membership Committee

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Established September 19, 1946
Meets third Thursday of each month
except July and August

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W. P. Wilson, First Vice-Chairman
H. P. Clark, Second Vice-Chairman
H. N. Clark, Secretary-Treasurer
Box 31, Carlsbad, New Mexico
E. W. Douglass, Section Delegate
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Established October 17, 1940

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P. O. Box 836, Blacksburg, Va.
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James B. Benson
C. R. Bourlund
L. I. Cothern
George E. Keller
John T. Parker
H. O. Zimmerman

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Established February 26, 1914
Holds dinner meeting first Wednesday
of each month, October to May inclusive,
at the Chicago Bar Association

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Inland Steel Co.
East Chicago, Indiana
H. A. White, Section Delegate

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Dennis Carney, Membership
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Established April 17, 1936

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3679 Woodridge Road
Cleveland 21, Ohio
William Baldwin, Jr., Treasurer
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Established May 23, 1913

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Cripple Creek, Colorado

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Established November 24, 1911
Holds meetings first Friday of each month except July and August

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3427 W. Kiernan
Spokane, Washington
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Spokane, May 1952
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Established September 30, 1947

Holds meetings second Wednesday, October, December, February and April

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William Mounce, Membership
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Established September 18, 1946

Holds meetings second Tuesday each month except June, July and August

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Established February 18, 1936

Holds meetings third Monday of each month except June through September

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Established April 18, 1940

Holds meetings second Tuesday of each month except July through September

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Established March 25, 1927

Holds meetings second Wednesday of each month

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March—J. C. Rintelen, Jr.
April—Ben D. Roberts
May—Mallory L. Miller
September—A. L. Washburn
October—Randolph S. Murray, Jr.
November—Eugene M. Thomas
December—Paul F. Deisler
January—Russell R. Whittington

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Established September 27, 1949

Holds meetings the first Monday of each month

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Bartow, Florida
Allen T. Cole, Section Delegate
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Ernest Greene, Steering
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Lawrence Frye, Program

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Established December 13, 1935

Holds meetings the third Tuesday of each month

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A. B. Stevens, Second Vice-Chairman
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P. O. Box 1407
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B. C. Elsley
W. D. Smith, Jr.
E. F. Stratton
Walter Rose
G. G. Wrightsman

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Established November 17, 1948

Holds meetings third Wednesday of each month except June through August

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G. J. Decker, Vice-Chairman (*Wichita*)
E. S. Arnold, Vice-Chairman (*E. Kansas*)
J.W. Meyers, Vice-Chairman (*W. Kansas*)
H. L. Temple, Secretary-Treasurer
Continental Oil Co.
Moundridge, Kansas
G. L. Yates, Section Delegate

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B. B. Lane — Lyman Terry

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L. L. Terry — R. V. Gerner

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Will D. Ford — John T. Gary
Dennis Krehbiel — Mac. W. Miller

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Established March 27, 1924

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J. S. Marsh, Vice-Chairman
J. L. Rodda, Vice-Chairman
D. J. Blickwede, Secretary
Bethlehem Steel Corp.
Bethlehem, Pa.
C. A. Lorenson, Treasurer
R. T. Gallagher, Section Delegate
B. J. Larpenteur, Manager
W. A. Griffith, Manager
R. T. Gallagher, Manager

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Allison Butts — C. E. Taylor, Jr.
M. S. Childs — P. L. Steffensen

MID-CONTINENT
Established December 28, 1917

Holds weekly luncheon meetings each Thursday in Tulsa, Oklahoma. Regular Section meetings held second Monday each month except June through August.

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G. C. MacDonald, First Vice-Chairman
M. B. Penn, Second Vice-Chairman
S. F. Bird, Secretary-Treasurer
Amerada Petroleum Corporation
Tulsa, Oklahoma
J. N. McGirl, Section Delegate

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E. H. Nielsen
F. H. Calloway

(OUTSIDE TULSA)
J. A. Murphy
F. H. Poettman

(EX-OFFICIO)
Roy H. Smith
J. N. McGirl

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Established December 20, 1920

Annual meeting second week in January, other meetings as called by officers

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J. L. Severson, Vice-Chairman
James R. Stuart, Secretary-Treasurer
Box 840, Hibbing, Minn.
Eugene P. Pfleider, Section Delegate

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C. J. O'Connell

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Clarence H. Sleeman, Secretary

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F. D. DeVaney, Chairman
S. E. Erickson, Vice-Chairman
M. F. Williams, Secretary

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Established October 17, 1913

Holds meetings fourth Tuesday of each month

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Fred W. Strandberg, Vice-Chairman
Clifford J. Hicks, Secretary-Treasurer
526 Hennessy Bldg., Butte, Montana
Joseph T. Roy, Executive Committee
James F. Smith, Executive Committee
Fred W. Strandberg, Section Delegate

COMMITTEES

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Stanley M. Lane — Forbes Robertson
James F. Smith

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Carl Trauerman, Co-Chairman
Lester Bishop — W. Wallace Harrity
George W. Boulter — Stanley M. Lane
Thomas K. Graham — Robert L. Thompson
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Mining—T. Charles Wise
Charles S. Matthews

Geology—Charles C. Goddard, Jr.
Wallace A. O'Brien

Metallurgy—C. F. Milkwick
George T. Hanson

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Mining—Arthur C. Bigley
Geology—Edward P. Shea
Metallurgy—George G. Griswold
General—J. R. Van Pelt

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Armor B. Martin J. Hollis McCrea

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Established January 21, 1916

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A. C. Rice, Secretary-Treasurer
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Box D, University P. O.
Reno, Nevada
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Holds luncheon meeting second Friday each month except July and August

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Nevada Bureau of Mines
Univ. of Nevada, Reno, Nev.

NEW YORK
Established May 19, 1911

Holds monthly meetings except February, June, July, and August

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Louis C. Raymond, Vice-Chairman
Alvin W. Knoerr, Secretary
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L. H. Hart
Maxwell Gensamer
Walter S. Olson
G. Howard LeFevre
A. L. J. Queneau

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Established March 28, 1913

Holds meetings third Thursday each month except June, July, and August.

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A. H. Mellish, Vice-Chairman
M. E. Elmore, Secretary-Treasurer
5041 West Prince St.
Seattle 6, Washington
W. A. G. Bennett, Corresponding Secretary
W. C. Leonard, Section Delegate
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Councillors
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PROGRAM
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Joseph Daniels C. R. Low
E. A. Rowe, Student Chapter Counselor

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Established May 16, 1945

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Henry Gruy, Vice-Chairman
Buck Joe Miller, Vice-Chairman
M. I. Taylor, Secretary-Treasurer
P. O. Box 1290, Fort Worth, Texas
Jack A. Crichton, Section Delegate
R. G. Parker, Alternate

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R. P. Dobyns Everett G. Trostel
Paul M. Wiley

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Dallas—N. A. Tinker

Arrangements
Fort Worth—W. K. Daggett
Dallas—H. A. Metzger

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Fort Worth—R. H. Rantala
Dallas—K. F. Anderson
Committee Chairman
Wichita Falls Area—Buck Joe Miller

OHIO VALLEY

Established November 19, 1920

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William H. Smith, Vice-Chairman
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